Product Engineering

FEBRUARY 1954

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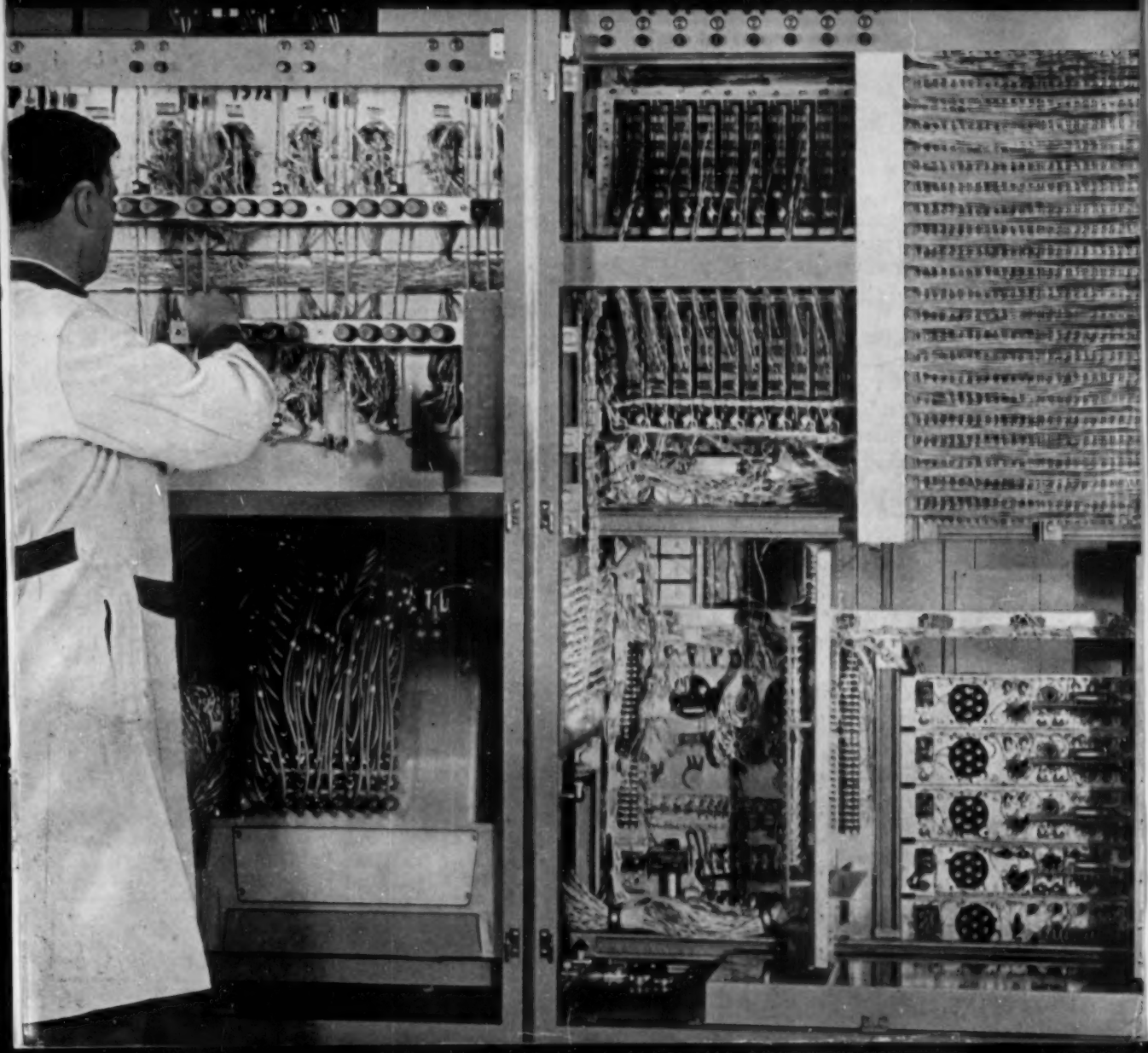
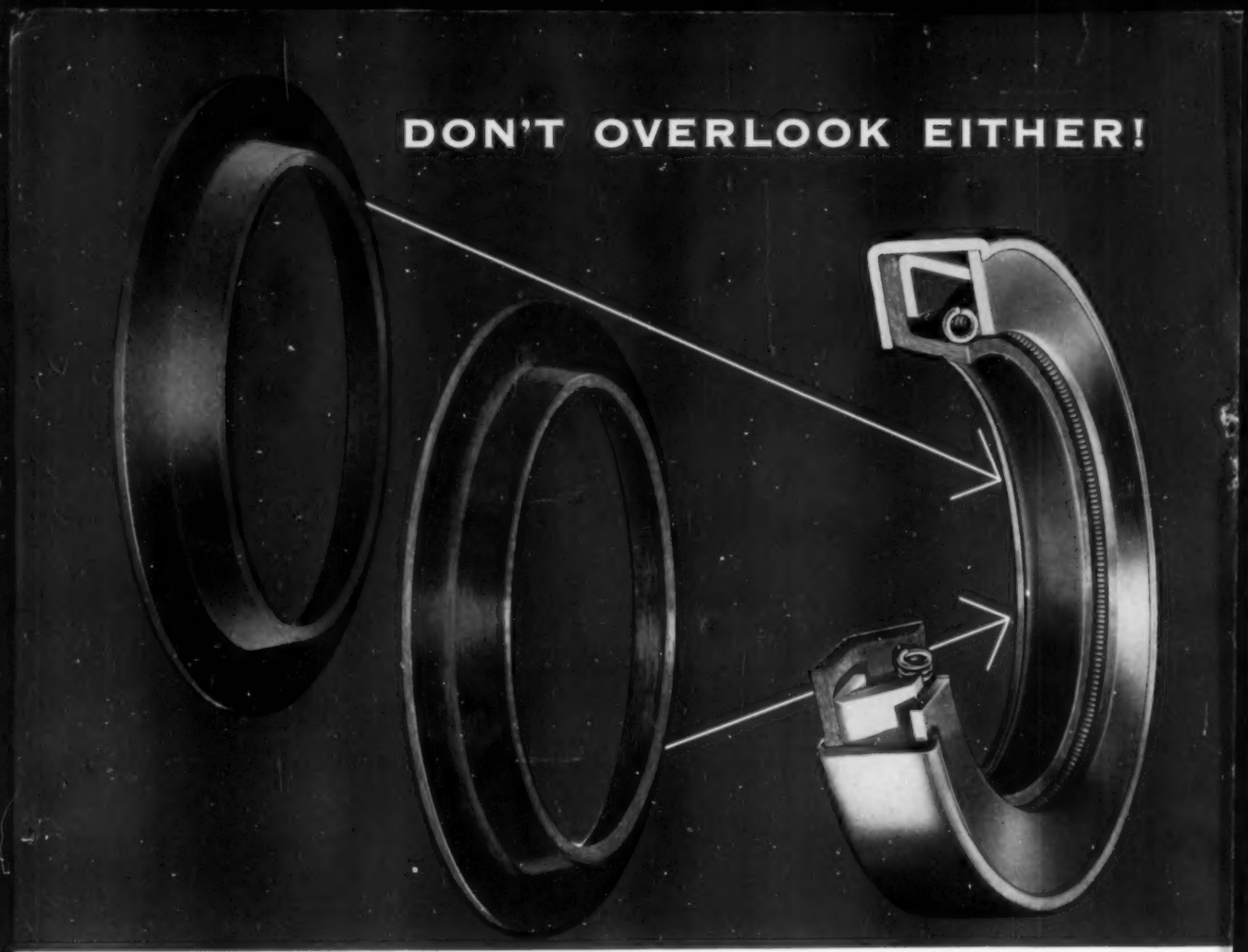
Functional Aspects of Design
Seven Ways of Forming Magnesium Sheet
Constant Torque Power Cams
How to Select Selenium Rectifiers
Silicone Dielectric Materials
Vibration Isolation of Machines





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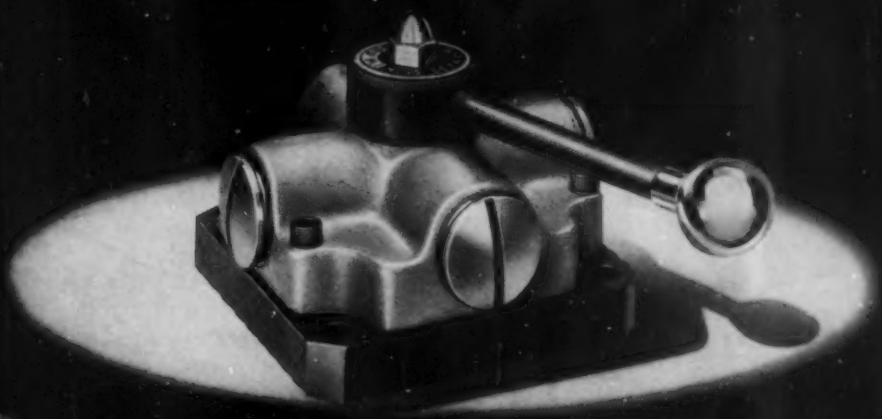

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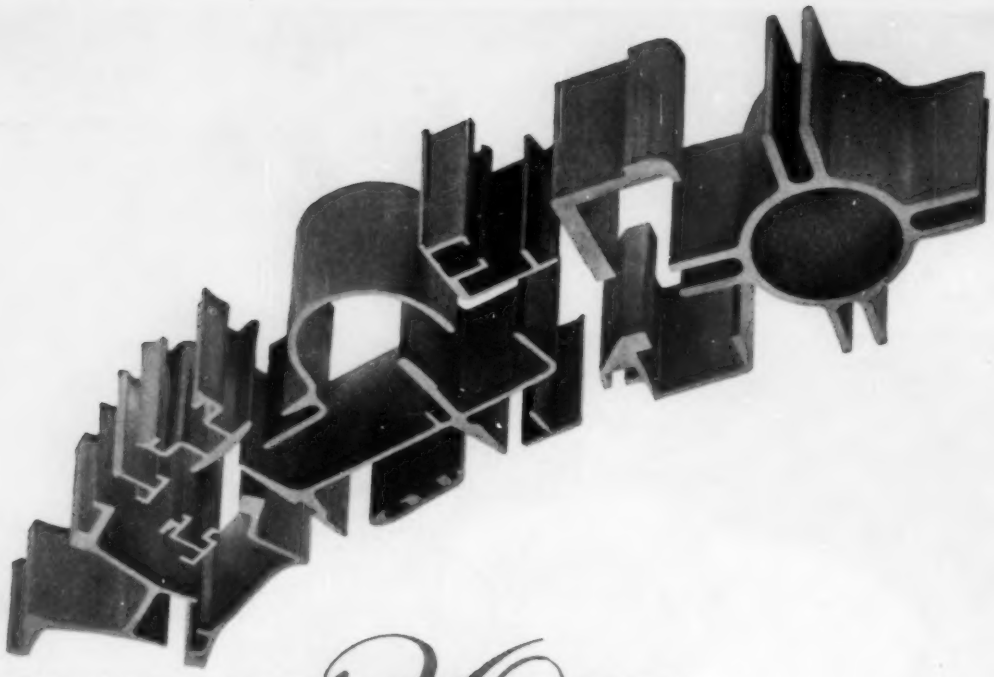

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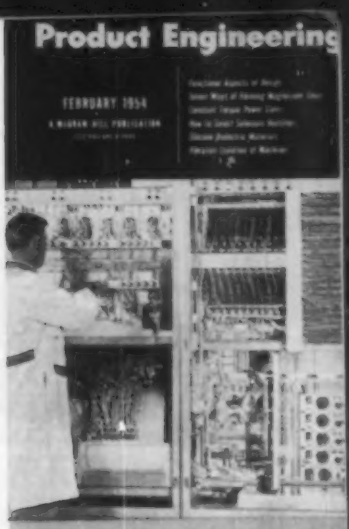

THIS MONTH'S COVER

The ERA Speed Tally System pictured on this month's cover is not a computer in the ordinary sense. A data storage device that can be used for high speed tallying and inventory record keeping, it is a scaled down version of a larger unit previously designed by Remington-Rand for military use. Consisting of ten operator's keyboard-indicator sets, a punched tape reader-punch, a magnetic drum memory, and an output printer, it will keep track of three categories of tallies for 13,000 items. Design details on pages 154 to 159.

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CIRCUITS
IMPULSES
FOR 5' IMPULSES
NOTE—FOR EXAMPLE
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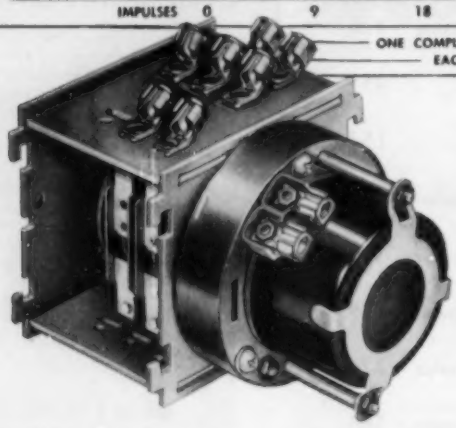
ONE COMPLETE ROTATIONAL CYCLE OF 30 & 45 SECOND TIMER & CAM
EACH SMALL DIVISION = 1 QUICK IMPULSE OF 5 DEGREES

PLOT the time cycle for your product HERE!



This Mallory Interval Timer Switch is designed so that the total time cycle can be varied from zero to as much as 72 minutes.

Operations can be controlled for intervals as short as 30 seconds and with as many as 36 operations in a 72 minute cycle.

The switch will control up to 14 different circuits and the actuation of a pilot light or buzzer signal can be included in the circuitry.

The timer switch has a 15 ampere current rating and ⅓ horsepower rating at 125 volts.

Other timer switch designs are available in both rotary and lateral form to cover time cycles up to 24 hours and more . . . with current ratings up to 25 amperes at 250 volts.

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In addition to switches of this type, Mallory Push Button Switches and combined automatic timer and push button switches are available in designs that will meet the requirements of a wide variety of equipment. Our engineers will be glad to work with you on your switch design problems . . . give you the advantage of years of experience in diversified switch development and manufacturing that often permits us to produce switches for special purposes without the cost and delay of special tooling.

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

METALLIC MATERIALS

. . . . Approximately ½ of the output of magnesium die casting is being used by the automotive industry. According to Doehler-Jarvis, Toledo, Ohio, decorative parts have been used for the past three years without complaints or manufacturing difficulties. Semi-structural parts, such as clutch housings, have been in use for 1½ years with no field returns. Sand cast magnesium parts have shown similar service life without trouble. However, where wear is a factor, aluminum has been generally more resistant.

IMPROVED MG ALLOY . . . .

. . . . The addition of 2-3 percent of thorium to magnesium casting alloys imparts outstanding mechanical properties to the alloys at ambient and elevated temperatures. Dominion Magnesium Ltd., Haley, Ontario, reports that properties are uniform throughout the castings and do not appear to be affected by section thickness. The good ductility of alloys containing thorium indicates that castings can be formed by either hot or cold working, and repairs can be made by welding. For best creep resistance an alloy of 3 percent thorium, 2.3 percent zinc and 0.7 percent zirconium is suggested.

SPECIAL ALLOY . . . .

. . . . Developed originally for watch mainsprings, Elgiloy, a special alloy, is to be released for general industrial use. Elgin National Watch Co., Elgin, Ill., states that the alloy can be used for flapper valves and diaphragms and is undergoing tests for fabrication of corrosion resistant anti-friction bearings.

CONTROLLED STEEL . . . .

. . . . Experiments are to be made to control the machining quality of steel by means of sulphur content. The Bureau of Mines' Pittsburgh experimental station believes that a jet spray of sulphur and other alloying agents into molten steel baths can produce a steel of controlled quality for machining.

HIGH TEMPERATURE STEEL . . . .

. . . . A modification of a high temperature gas turbine steel, 16-25-6 (16 percent chromium, 25 percent nickel, 6 percent molybdenum), has been made without affecting the temperature or ductility characteristics of the material. Timken Roller Bearing Co., Canton, Ohio, reports that the modified steel, 16-15-6, retains the high temperature values, saves on critical nickel and has better ductility than the 16-25-6 combination. Nickel is saved by increasing the manganese content from 2.0 percent to 6.5-8.5 percent.

RARE EARTHS . . . .

. . . . The rare earths, such as neodymium and praseodymium are being used in combination with aluminum to improve the high temperature qualities. According to the American Metallurgical Products Co., Pittsburgh, Pa., commercially-practical, high temperature aluminum alloys will be developed using the rare earths in metallic form.

NONMETALLIC MATERIALS

. . . . A new glass-based enamel is designed to multiply the short-life span of iron and steel equipment exposed to corrosive chemical attack by hot liquids and gases at temperatures ranging up to 1,400 F. A joint development by Battelle Memorial Institute and Barrows Porcelain Enamel Co., Cincinnati, Ohio, it holds promise for industries engaged in chemical, lead, zinc, magnesium and aluminum processing. Studies have shown that the coating material markedly increases the service life of iron or steel parts in molten aluminum and is claimed to be more protective than existing porcelain enamels for this application.

HEAVY NYLON PARTS . . . .

. . . . The injection molding of a 50 oz gear blank made from nylon is opening up new avenues for the plastic industry. A. L. Hyde, Grenloch, N. J., reports that the blank will be the main drive gear for a textile loom. The finished gear will be 8½ in. dia and 2 in. thick and will require no lubrication. The company states it can produce nylon parts weighing 6 or 7 lbs.

TEFLON ADHESIVE . . . .

. . . . An adhesive for binding Teflon to Teflon or Teflon to metal and other materials is a development of the Flexrock Co., Philadelphia, Pa. The company states that the adhesive has good acid and alkali

(continued on page 7)

RESISTS almost EVERYTHING

KEL-F* properties

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- Wide Temperature Utility—from −320° F. to +390° F.
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Check the partial list of KEL-F properties. Determine for yourself where and how these characteristics can improve your product or procedures. If the application is highly specialized, then the Kurz-Kasch method of compression-transfer moulding *might* be your logical answer.

As examples of the benefits you can expect, the chemical pump parts and integrally-moulded valve liners pictured above will, through their chemical inertness alone, give infinitely more satisfactory service and freedom from expensive maintenance and replacement. Also, note a large electrical insulator moulded around a complex insert.

These are the kinds of fluorocarbon applications we specialize in—those parts that can best be compression-transfer moulded. Send us your inquiries on KEL-F—on Teflon—on moulded glass-filled polyesters—or any thermo-setting materials. We're equipped and ready for compression, transfer and plunger moulding exclusively—and anxious to work into your plans for the earliest feasible moment. Just write or call.

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resistance and excellent electrical properties. It can be applied by brushing, dipping or spraying, and can air dry. Heating, however, results in greater adhesive strength. Tests indicate a peel strength of over 1,000 gm per in. or a direct pull of 12-15 psi for Teflon to Teflon and Teflon to stainless steel.

IMPROVED SILICONE RUBBER . . . .

. . . . New development in silicone rubber is claimed to have the lowest long term shrinkage (1.8 to 2.5 percent) and the lowest compression set values. Dow Corning Corp., Midland, Mich., reports it is serviceable at temperatures ranging from below —100 to above 500 F. Product is for use as gaskets, O-rings, seals and molded rubber goods.

COMPACT FILTERS . . . .

. . . . Filters for such high corrosive chemicals as fuming nitric acid, hydrochloric acid and hydrogen peroxide—typical liquid propellants for rocket engines —have been developed by the Porous Filter Co., Glen Cove, N. Y. Porous Kel-F is used as a filter medium and separates all particles larger than 5 microns in liquid filtration and much finer particles in gas filtration. Filter can be used—according to the manufacturer—at temperatures up to 350 F and is claimed to be resistant to thermal shock.

LOW SHRINKAGE PLASTIC . . . .

. . . . A new thermosetting molding material with improved arc resistance and dimensional stability has been developed by Monsanto Chemical Co.'s. Plastic Div. The material has high arc resistance, measured at 184 sec. in standard ASTM tests. Good dimensional stability means that the problem of after-shrinkage has been virtually eliminated. The material is claimed to have good moldability, relatively good impact strength, and high heat resistance.

COMPONENTS

. . . . Relay springs, normally made from nickel, silver or phosphor bronze, are being made from aluminum alloy, according to Hasler S.A., Berne, Switzerland. The springs are plated with pure aluminum to increase the surface conductivity and the spring ends are nickel plated to permit soldering. Tests of such springs indicate they have satisfactory life and electrical properties. Manufacturer states that, although these tests (conducted over the past six years) have been successful, substitution of aluminum for phosphor bronze has not been generally adopted because of the higher aluminum price.

LONG-LIFE STORAGE BATTERY . . . .

. . . . Industrial storage battery claimed to have a life expectancy of 10-20 years has been developed by the Sonotone Corp., N. Y., N. Y. The battery uses nickel cadmium of a special sintered plate type and employs an alkaline solution instead of acid. The battery is about ½ the size of standard units. The battery is claimed to be invulnerable to shock and vibration, reverse charging, or short circuiting. Initial cost will be two to five times conventional batteries.

TITANIUM FASTENER . . . .

. . . . Development of a new light-weight, vibration-proof locknut for aircraft adds to the list of titanium fasteners. The Elastic Stop Nut Corp. of America, Unionville, N. J., report that nuts weigh half that of steel nuts of the same thread yet meet the same tensile requirements. The nuts are to be used by the Republic Aviation Corp., Farmingdale, N. Y., for research concerning the use of titanium in aircraft.

TRANSISTOR MANUFACTURE . . . .

. . . . A radically new technique for making transistors that will enable them to be operated at much higher frequencies has been reported by the Philco Corp., Philadelphia, Pa. New process uses electroplating instead of more difficult laboratory-type techniques previously employed. Company believes new method will allow mass production and thereby open new avionic fields to the transistor.

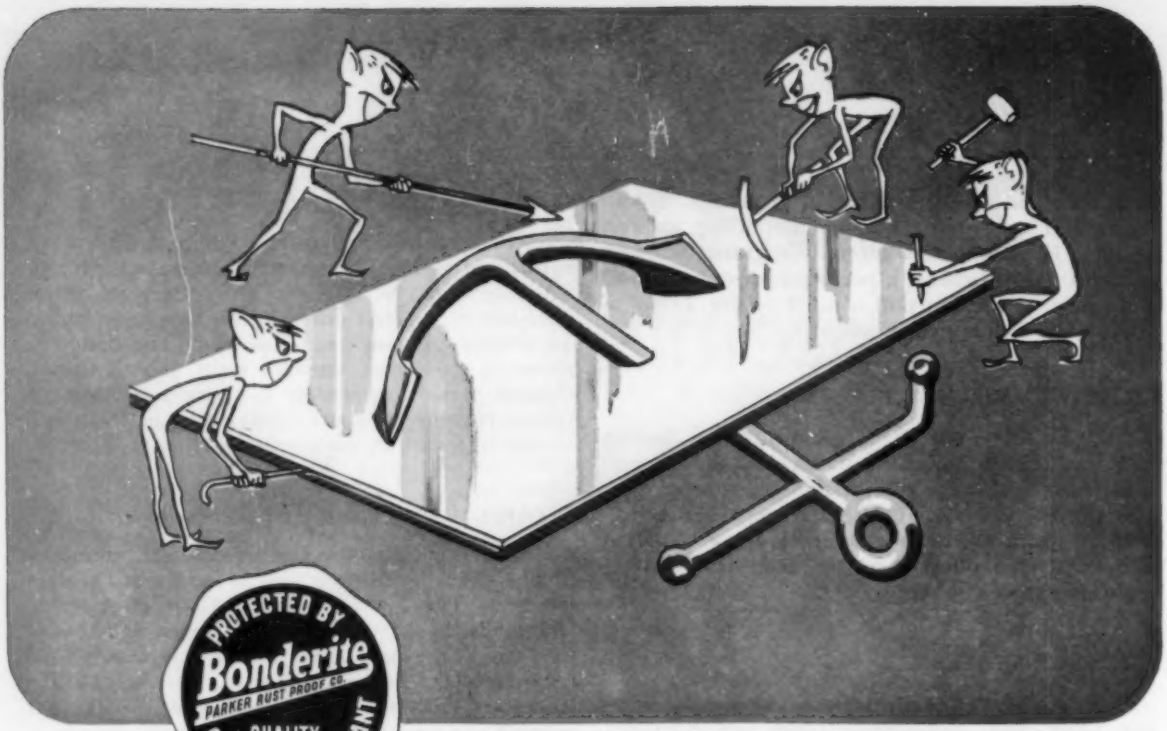
PROCESSES

. . . . A patented process for the production of powdered iron has been perfected and is to be used for commercial production. Republic Steel Corporation states that very pure iron powder in substantial amounts can be produced from low or high grade ore by the process. A variation of the process, it is claimed, will permit the production of sponge iron that might be used to produce tool or high grade steels. Experiments indicate that the process might also be successfully employed to produce nickel and manganese from low grade ores.

HEATING FURNACE . . . .

. . . . A new type of slab heating furnace is going into operation at the Brackenridge, Pa., plant of Allegheny Ludlum Steel Corp. The furnace is claimed to take 70 tons of stainless steel and heat it from room temperature to 2,275 F in one hour.

(continued on page 9)



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BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces

Highlights –

DIE CLEANER . . . .

. . . . Liquid blasting is being used to clean dies used for forging or casting brass fittings, nozzles, valves and strainers by the Imperial Brass Mfg. Co., Chicago, Ill. Cleaning costs are reported to have been reduced by $22,500 per year, and die life increased by 15 percent. The liquid blast cleans with a stream of suspended non-metallic abrasive of talcum powder size or finer. The cleaner removes heat scale and carbon deposits, saving two hr on average size dies and three hr for larger more complicated dies.

TITANIUM GRINDING . . . .

. . . . The susceptibility of titanium to heating is one of the problems in finishing the metal, according to the Carborundum Co., Niagara Falls, N. Y. Grinding wheel speeds using 2,000 sfpm (as opposed to a normal 6,000 sfpm) result in faster stock removal on titanium, but finishes are not always satisfactory. The problems associated with the grinding of stainless steel are somewhat comparable.

RUBBER TO NYLON . . . .

. . . . A process for bonding certain rubber compounds to nylon as well as to metal has been developed by the Minnesota Rubber and Gasket Co., Minneapolis, Minn. The rubber-to-metal process is already being used. The nylon bonding technique is expected to eliminate need for metal inserts where nylon is used as a bearing for rubber parts.

TESTING

. . . . Research and laboratory tests have indicated that a bearing alloy containing 30 percent Cu, 30 percent Ag, and 40 percent Pb, will have satisfactory mechanical properties under conditions of higher speeds, heavier loads and severe operating conditions. Bristol Aeroplane Co., England, reports that its low modulus of elasticity assures conformity of the bearing under design loads, corrosion resistance is good, embedability is about 60 percent of the tin base alloy, and wear and fatigue properties appear adequate. The alloys high temperature properties are better than those of the tin-base alloy.

ELECTRONIC CAMERA . . . .

. . . . A camera capable of taking pictures in one-tenth of one millionth of one second and having no moving parts and using very little electrical power is a development of the Hycon Mfg. Co., Pasadena, Calif. A Kerr cell acts as the shutter and consists of two screens of polarized material separated by a solution of nitrobenzene. An electronic device applies a high electrical potential across the cell. The shutter holds out light until the electrical charge realigns the molecules of nitrobenzene, thus permitting light to pass through the cell and onto the film.

TURBULENCE ORIGIN STUDIED . . . .

. . . . A new research program to locate the origin of turbulence in fluid flow is being conducted at Rensselaer Polytechnic Institute, Troy, N. Y. The study is to devise a method to locate experimentally the origin of turbulent flow either in pipes, channels, or free surfaces. Once developed, the method will be used to check theories of the mechanism of turbulence.

PIPE RESEARCH . . . .

. . . . A research program to establish effective test methods on various types of plastic pipe is to be carried on at the Battelle Memorial Institute, Columbus, Ohio. Technical data on burst strength; long range serviceability under static pressure and dynamic loading; safe working pressures; and effect of water hammer and reciprocating pumps will be determined.

BORIDE EXPANSION . . . .

. . . . Borides in combination with zirconium, chromium and molybdenum are headed for new importance with the establishment of a research and development center. Firth-Sterling Inc., American Electro Metal Corp., and Carborundum Co., have concentrated their funds and facilities into the Borolite Corp., Niagara Falls, N. Y., to develop metal borides for military and civilian applications. Joint facilities will allow for faster and broader development work.

OPTICAL DESIGN . . . .

. . . . Electronic computing equipment is being used to solve complex optical design problems. Armour Research Foundation, Chicago, Ill., reports that a new ray-tracing device and the electronic calculator track light rays through optical systems. The resulting information can be used to determine what will happen in lens systems that are being planned.

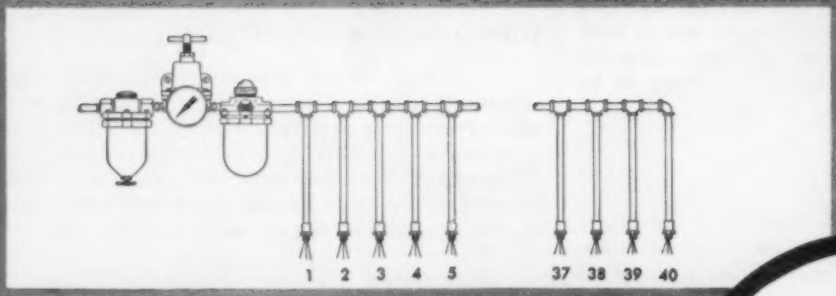
THREE FUEL ENGINE . . . .

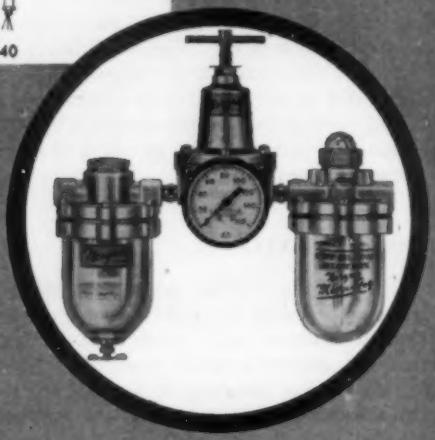
. . . . Development of an engine that can be operated with diesel fuel, gasoline or kerosene is being completed by Diesel Power Inc., Reynolds, Pa. The engine has a specially developed combustion chamber with fuel injection under high pressure.

tests prove

Norgren Micro-Fog Lubricator

• gives absolutely uniform lubrication thru 40 outlets





The extremely fine air-borne Micro-Fog provides absolutely uniform distribution of lubricant through as many as 40 outlets... for bearings, spindles, gear boxes, etc.

Two exclusive features of the Norgren Micro-Fog Lubricator—constant oil level and metering of oil feed by air—assure an exactly uniform and accurately regulated rate of feed.

Norgren Micro-Fog lubrication systems have enabled hundreds of manufacturers to obtain greater flexibility in product design and plant layout; improve equipment performance; and reduce maintenance costs.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

VALVES • FILTERS • REGULATORS • LUBRICATORS • HOSE ASSEMBLIES

Vitalizer Unit for tools, cylinders, etc.

Micro-Fog Lubro-Control Unit for bearings, spindles, gear boxes.

Micro-Fog Lubro-Control Unit for tools and cylinders requiring regulated air pressure.

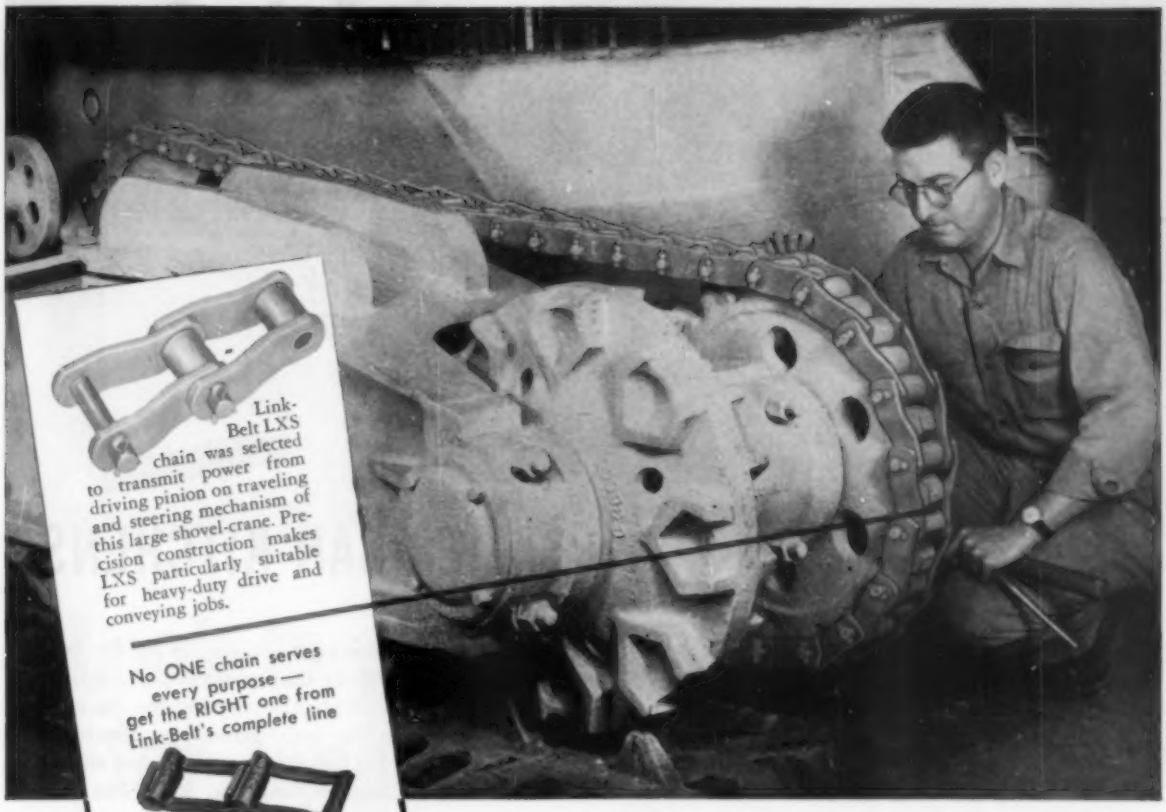
Micro-Fog Lubricator, tank type, 1¾ gal. cap.

WRITE FOR NEW CATALOG No. 600

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

For long chain life under severe drive or conveyor service...it's

LINK-BELT LXS



Link-Belt LXS chain was selected to transmit power from driving pinion on traveling and steering mechanism of this large shovel-crane. Precision construction makes LXS particularly suitable for heavy-duty drive and conveying jobs.

No ONE chain serves every purpose — get the RIGHT one from Link-Belt's complete line

Steel Link-Belt for moderate-strength power transmission and conveying. Also available in malleable.

Class C combination chain—popular, durable, low cost design for elevators, conveyors.

Class H Pintle chain—excellent for conveyors that slide because of broad wearing surfaces.

Class 400 Pintle chain—closed end design keeps out dirt, makes excellent service medium for drives, elevators, conveyors.

LINK-BELT offers the chain that's best for every job

Here's a fabricated steel roller chain that outlasts, outperforms ordinary chain where the going is tough. Accurate sizing of full-round pins, bushings and pitch holes assures users of Link-Belt LXS chain closer joint fit . . . better wear resistance.

Manufacturing refinements such as these are typical of every chain in the complete Link-Belt line. Accurate control of raw material specifications and manufacturing processes results in uniformity . . . longer chain life.

For all the facts on LXS chain, and for information on the complete line of Link-Belt chains and sprockets, see the Link-Belt sales representative nearest you. Send for Folder No. 2454.

LINK-BELT

CHAINS & SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Sydney; South Africa, Springs. Representatives Throughout the World. 13.303

DIE CAST OF ZINC

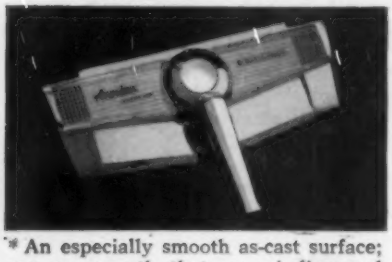
for AMERICAN KITCHENS

Here's Why ....

Appearance, the prime requisite in metal trim for home appliances, is one of the chief virtues of ZINC Die Castings. The two parts above—the principal components of the handle assembly for the American Kitchens dishwasher—are cast with a hardware finish* and are handsomely chromium plated, easily and economically. When a plated die casting is called for, ZINC gets the call.

But other important economies are realized by designing these parts specifically for die casting of ZINC. All of the openings and recesses required for assembly are cored in the die casting operation. The only secondary operations performed on the pictured castings were simple trimming, drilling and tapping. The close cast tolerances insure trouble-free assembly and the inherent strength of ZINC Die Castings easily resists the rough usage to which the handle will be subjected in service.

Home appliances are just one of many fields in which ZINC Die Castings are finding ever-increasing use. For a more complete picture of the scope of application send for our new booklet "The End Uses of Zinc Die Castings."



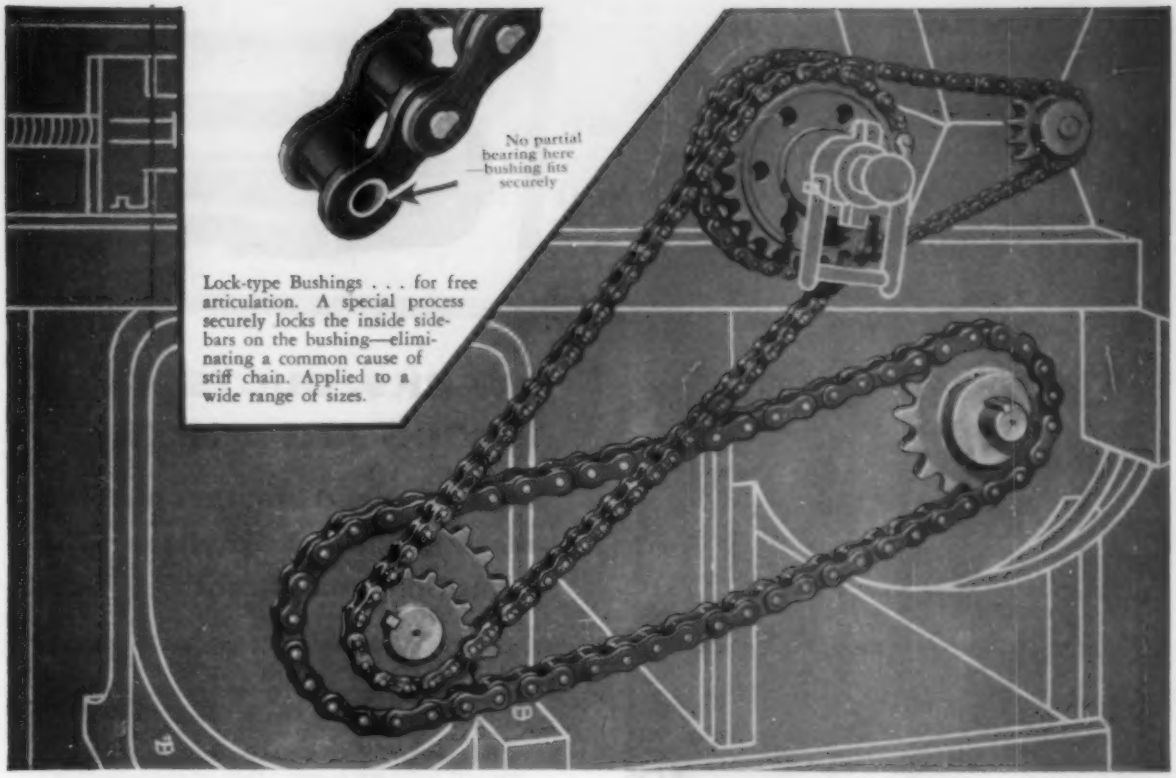
* An especially smooth as-cast surface; one so smooth that no grinding and little or no buffing are required to prepare the surface for plating.

Send for your copy

The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC


No partial bearing here —bushing fits securely
Lock-type Bushings . . . for free articulation. A special process securely locks the inside sidebars on the bushing—eliminating a common cause of stiff chain. Applied to a wide range of sizes.

Look to LOCK-TYPE BUSHINGS for longer roller chain life

Just one of many engineering extras you get from LINK-BELT

FOR drives that must operate under severe conditions, it will pay you to use Link-Belt Precision Steel Roller Chain. Lock-type bushings and the many other Link-Belt engineering extras add up to *built-in* extra life. Whether it's for power transmission or conveying, you are assured of a positive, flexible, economical chain . . . with high sustained efficiency. For complete information, see your nearby Link-Belt sales representative, or write for Engineering Data Book 2457.

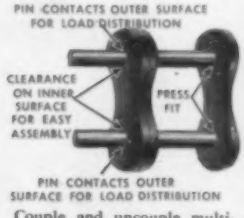
LINK-BELT

ROLLER CHAINS & SPROCKETS

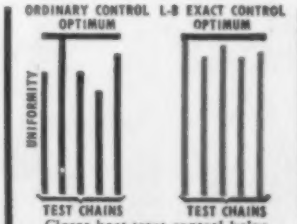
LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle; Scarboro, Toronto and Elmira, Ont. (Canada); Springs (South Africa); Sydney (Australia). Sales Offices in Principal Cities. 13,330-B

Don't overlook these other LINK-BELT extras

Shot-peened rollers have extra fatigue life under impact.

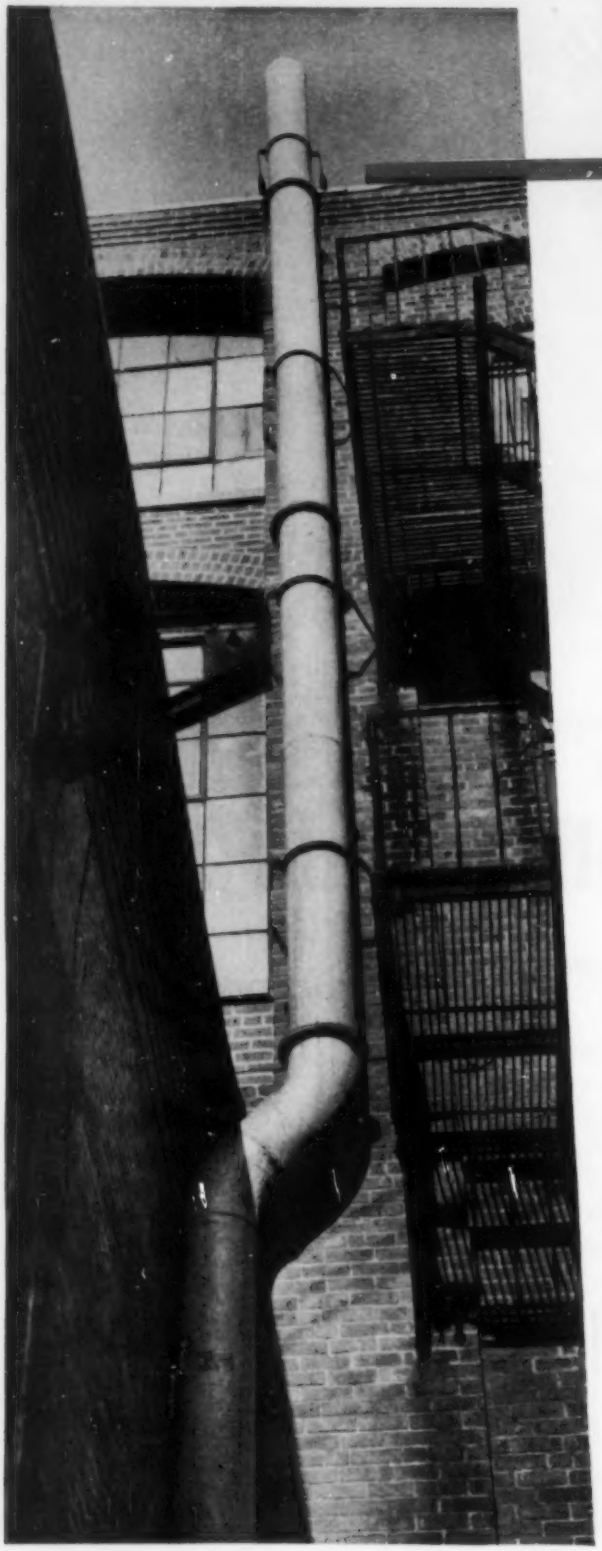

PIN CONTACTS OUTER SURFACE FOR LOAD DISTRIBUTION
CLEARANCE ON INNER SURFACE FOR EASY ASSEMBLY
PRESS FIT
PIN CONTACTS OUTER SURFACE FOR LOAD DISTRIBUTION

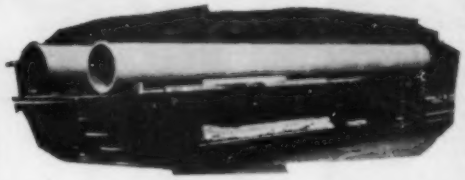
Couple and uncouple multiple-width chains more easily.



Closer heat treat control helps attain greater uniformity.

"Pla-Tank" Products are manufactured by
The Chemical Corporation, Springfield 9, Mass.





STACKS, DUCTS, HOODS AND PIPES

of reinforced plastic combine strength, light weight, and chemical resistance

Reinforced plastics produced from glass fibers bonded with BAKELITE Polyester Resins form the 40-foot long fume duct shown on the flatcar above and the 77-foot fume vent stack illustrated at the left.

Reinforced plastic structures combine high mechanical strength with light weight. They are easily handled and quickly assembled, usually without special rigging. They often eliminate heavy reinforcing of the base when mounted on roof framing. They won't rust, and their resistance to weathering and chemical attack reduces maintenance costs.

Other structures, such as pipes, ducts, hoods, and tanks are also produced from reinforced plastics made with BAKELITE Polyester Resins. According to the manufacturer, the pipe can carry corrosive liquids under moderate pressures. Pipe sections can be joined right in the field by "paint brush" welding—wrapping resin-soaked glass fiber mats around joints and curing them. Ducts and hoods have a one-piece molded construction that prevents leaks. Tanks are made in a great variety of standard and custom sizes for electroplating purposes.

To learn more about these large-scale reinforced plastic structures, and about the BAKELITE Polyester Resins that make them possible, write Dept. SY-10.

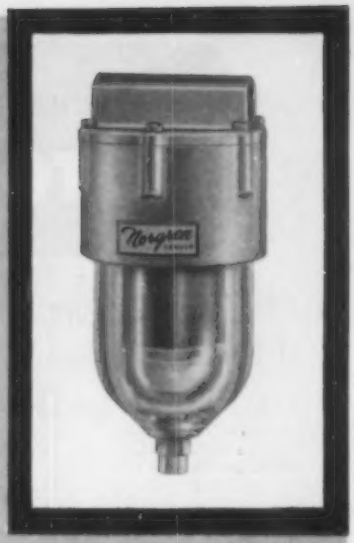
BAKELITE
TRADE-MARK
POLYESTER RESINS

TRADE MARK

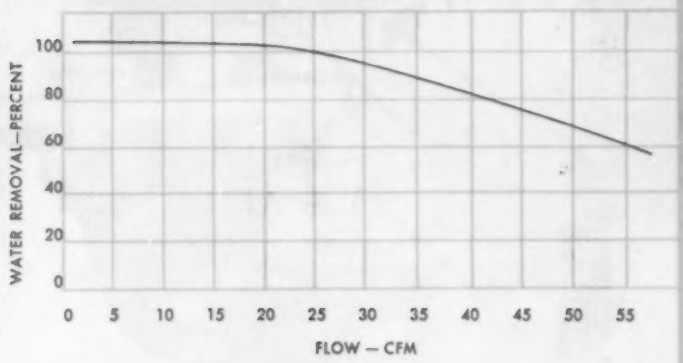
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.
In Canada:
Bakelite Company (Canada) Ltd., Belleville, Ont.

PERFORMANCE DATA PROVE

Norgren Automatic-Drain Filter's

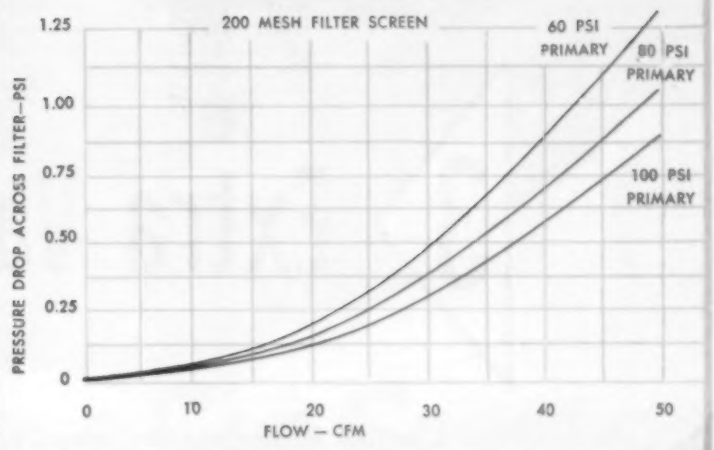


HIGH EFFICIENCY IN MOISTURE REMOVAL



operates whether air pressure is constant or fluctuating, whether or not air is flowing.

LOW PRESSURE DROP



Filtering the air that powers your tools, cylinders and other pneumatic equipment is essential if you want better equipment performance and more output with lowest maintenance costs.

The new transparent bowl Norgren Automatic-Drain Filter gives you this vital protection automatically, whether air pressure is constant or fluctuating, whether or not air is flowing...assures clean, dry air under all conditions, without attention. Flow: 0 to 35 cfm; pressure; 30 to 150 psi; temperature: 40° to 120° F.

Drain operates automatically, but discharges only under full load to reduce wear and loss of air.

WRITE FOR NEW CATALOG No. 600

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

Valves • Filters • Regulators • Lubricators • Hose Assemblies

New transparent replaceable bowl filter for ¾" and 1" air lines. Water capacity 1 pint.

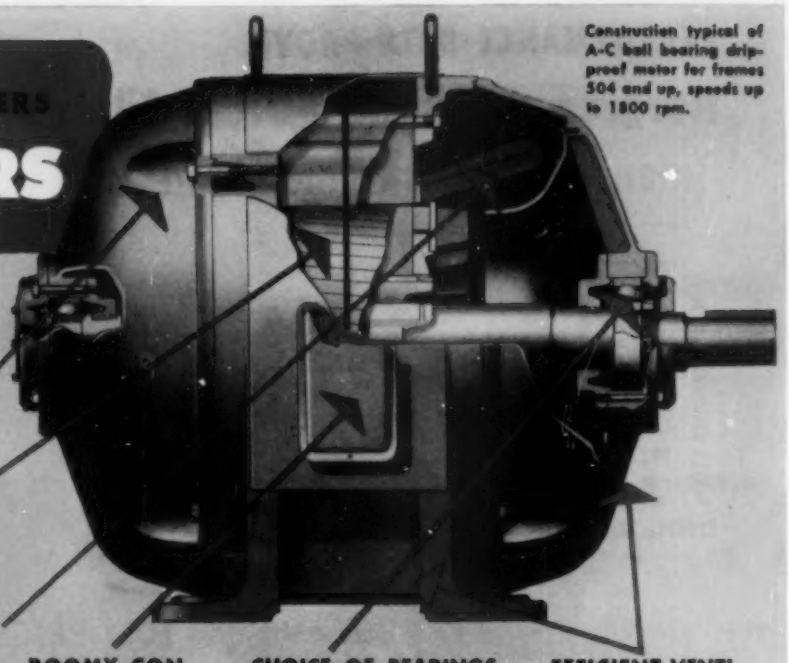
Replaceable metal bowl filter for ¼", ⅜" and ½" air lines.

Permanent metal bowl filter types for ¼" to 1½" air lines.

New, small replaceable bowl filter for ¼" and ⅜" air lines. Screw type clamp ring.

ALLIS-CHALMERS

MOTORS



Construction typical of A-C ball bearing drip-proof motor for frames 504 and up, speeds up to 1800 rpm.

All These Features of Good Motor Design

CAST IRON END SHIELDS— assure distortion-free bearing support for maximum bearing life, correct rotor alignment, uniform air gap.

BRAZED CAGE WINDING — copper or copper alloy cage bars are brazed to end ring to produce a practically indestructible rotor winding.

STATOR COILS—multiple-dipped, baked after each dip. Build up tough protection against heat, moisture and corrosive atmosphere.

ROOMY CONDUIT BOX — has ample room for easy connection of leads, may be rotated in 90 degree steps.

CHOICE OF BEARINGS — motors may be obtained with either ball or ring-oiled sleeve bearings. Ball bearings are housing mounted with provisions for in-service lubrication.

EFFICIENT VENTILATION — large intake and discharge openings with ample-sized fan assure a sweeping flow of cooling air. Careful baffling of air flow and plenty of space back of stator core assure adequate, even cooling.

3 Extra Values

1 Nation-Wide Certified Service — Allis-Chalmers Certified Service Shops located throughout the country provide factory-approved parts and service on your Allis-Chalmers motors. A-C Certified Service Shops are independently owned shops that meet the strict A-C standards for modern equipment, experience, and business integrity. They provide you with prompt, economical repair and maintenance.

2 Complete Drive From One Source Allis-Chalmers can supply your complete drive — control — motor — *Texrope* V-belt drive — from one convenient source.

3 Competent Engineering Help Your local Allis-Chalmers District Office representative or Authorized Distributor will be glad to help you select exactly the right motor for your needs. For additional information, write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B6052.

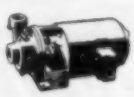
A-4227

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Distributors, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE V-belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.



PUMPS — Integral types from ¾ in. to 72 in. discharge and up.

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

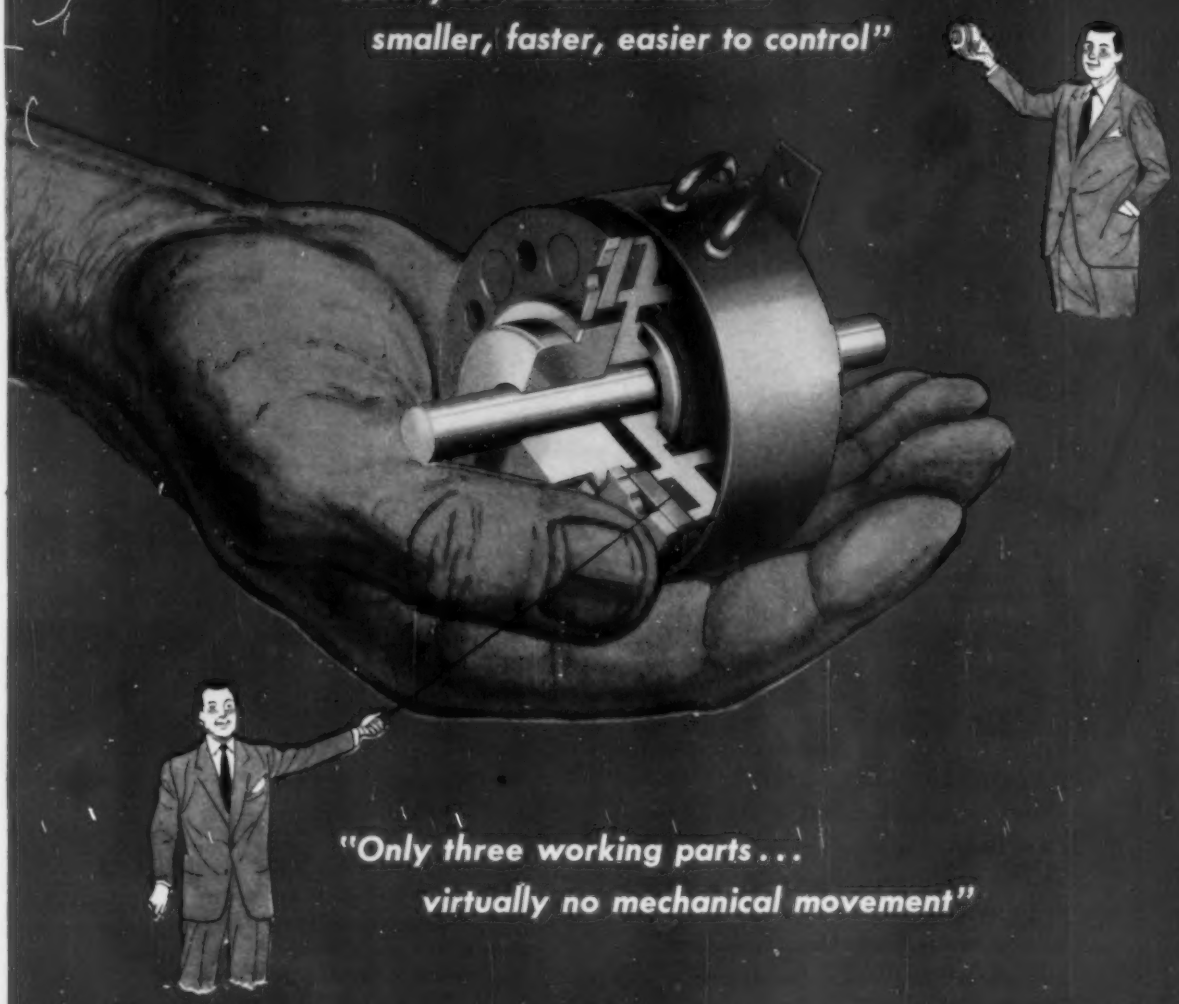
REPORTER AT LARGE . . . that's what you might call this new Veeder-Root Reset Magnetic Counter . . . adaptable to remote counting from machines or processes to central boards or instrument-clusters, wherever you want to put them. NOW . . . what can your imagination do with these few facts? For the *full facts,* write:

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"Counts Everything on Earth"

WARNER ANNOUNCES NEW...SMALL...COMPACT ELECTRIC BRAKES & CLUTCHES

"Now your machines can be smaller, faster, easier to control"



"Only three working parts... virtually no mechanical movement"

Surprising high torque . . . ideal for light machines and servo drives . . .

For light machine, instrument and servo drives, these new, smaller, more responsive Warner Electric Brakes and Clutches offer exciting new opportunities for *precise, automatic control!* Electrically actuated, they're ideal for accurate indexing, inching and jogging, rapid cycling, synchronized starting and stopping, and numerous other motions requiring adroit engagement and release. Their new, *electro-magnetic* principle assures longer life . . . easier, more economical application to your product.

Stationary-field electric clutch couplings have only three working parts—a stationary magnetic field, rotor and armature. Replaceable-face electric brakes have just two elements—a rotating armature and stationary field with replaceable face. When the field is energized, the armature is attracted to the replaceable face or rotor for extremely fast, accurate starts and stops. Mechanical movement is practically eliminated. Torque ratings from 8 to 240 inch lbs. Write for details!

Cut assembly time by 60% . . . weight by 8 lbs.!

Replacement of a mechanical clutch and linkage with the compact, smooth-operating Warner Stationary-Field Electric Clutch resulted in increased portability and simplified manufacture of this semi-automatic glue tipper. Clutch assembly time has been reduced 60% and total weight of the machine has been decreased by 8 pounds.

The "Tipmaster," manufactured by the Pierce Specialized Equipment Co., San Mateo, California, is a high-speed, economical producer of snap-out and carbon interleaved forms. The new Warner Model SF-250 Electric Clutch-Coupling, actuated by a foot-switch, controls operation of the glue fountain. A portable micro-switch permits either foot or knee control. Motor runs continuously and the clutch-coupling engages power to the driven shaft member until cam-operated micro-switch opens the clutch circuit, de-energizing the field coil. Operation is fast, easy . . . new design

permits savings and adds important sales features . . . Warner Electric Clutch saves wear and tear on the motor and drive.

Get these great new advantages in Brakes, Clutches, Clutch-Couplings!

High torque easily controlled—smooth, extremely high operating torque . . . positive engagement for heavy loads . . . no creep or slippage . . . voltage easily adjusted to give *soft* or *harsh* couples or stops.

Compact, lightweight—ideal for small electrically operated instruments and machinery . . . applications before limited because of space restrictions, high-torque needs.

Precise, accurate positioning—lightning-fast operation . . . engage and release cycles easily adjusted for any requirements.

Easy remote or automatic control—electro-magnetic principle permits automatic operation and remote control through limit switches, relays, electric eyes, and other electric controls.

Never need adjustment—automatic take-up for wear of friction surfaces eliminates servicing . . . replaceable face and rotor extend brake or clutch life indefinitely.

Simple design—only three operating parts—magnet, armature and replaceable face or rotor. Nothing to go wrong . . . easily wired into standard machine circuits using light-duty equipment.

WARNER

Beat competition with

ELECTRIC BRAKES AND CLUTCHES

WARNER ELECTRIC BRAKE & CLUTCH CO.,
Beloit, Wisconsin

Warner Electric Brake & Clutch Co.,
Dept. PE, Beloit, Wisconsin

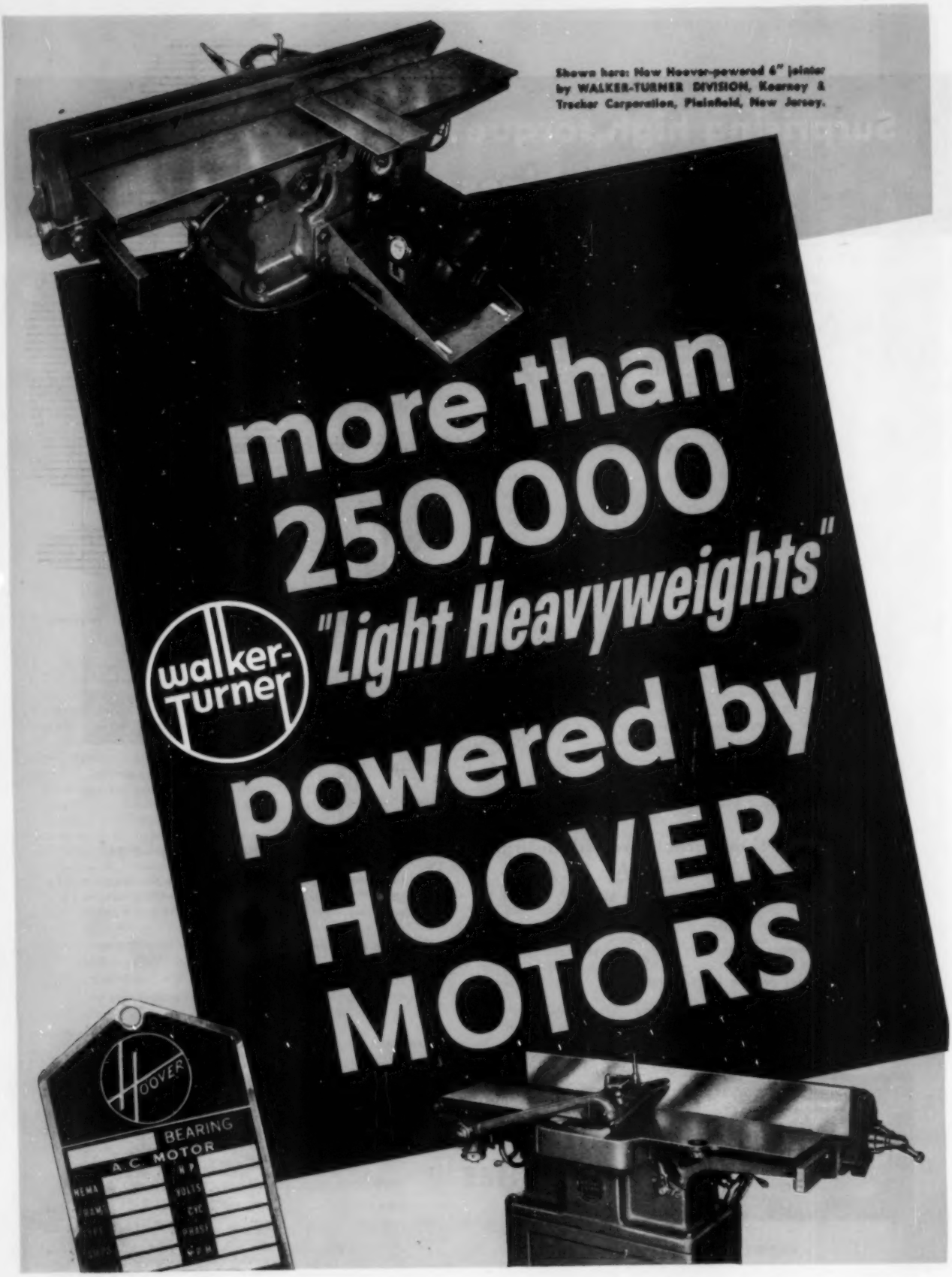
Gentlemen: Please send literature describing Stationary-Field Electric Clutches and Replaceable-Face Electric Brakes to:

Firm Name_____

Individual_____

Address_____

City_____ State_____


Shown here: New Hoover-powered 6" jointer by WALKER-TURNER DIVISION, Kearney & Trecker Corporation, Plainfield, New Jersey.
more than 250,000
walker-Turner
"Light Heavyweights"
powered by
HOOVER MOTORS
HOOVER
BEARING
A.C. MOTOR
H.P.
VOLTS
CYC.
PHASE
R.P.M.

For the past fifteen years, Walker-Turner has used Hoover-built "Driver" Motors, exclusively, as standard equipment on its famous Light-Heavyweight machines. Here's why, according to Walter Antener, Advertising Manager:

NO WASTE SPACE!

"These 'Driver' motors, like the machines they power, are also 'Light-Heavyweights.' They provide the full-rated power. They're compact. They've been tailored to fit the exacting requirements of all our wood and metal-working machines."

NO COMPLAINTS!

"They've given sure-starting, cool-running, smooth-running operation under the most adverse conditions—long and trouble-free service under extreme overload, heavy continuous usage and unfavorable installations. Atmospheres containing sawdust, dirt, metal chips and similar foreign elements have given us no complications."

NO COME-BACKS!

"In more than 250,000 installations, returns have been negligible. Every 'trouble call' has been quickly and easily taken care of and each customer completely satisfied. Hoover Service Agencies have given us finest follow-through in every case. "And these are just a few of the factors that prove Hoover 'Driver' motors real champions in our industry."

PRODUCTION FOR HOME AND DEFENSE
Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

ALL TYPES OF ELECTRIC MOTORS UP TO 5 H.P.

Whether you make industrial or domestic equipment, Hoover will help you power your product at lowest possible cost. The Hoover Electric Motor Catalog lists a wide variety of "in-production" models, fractional or integral, from 1/6 to 5 horsepower.

Or Hoover engineers will work out any special electrical or mechanical details needed to "tailor-make" your motor to your job. And whether your customer is located in Toronto, Topeka or Timbuktu — Hoover's world-wide service agency network will follow through for you. It will pay you to check with Hoover before you decide on any electric motor application. Send this coupon now.

THE HOOVER COMPANY
ELECTRIC MOTOR DIVISION
88 BROOK AVENUE, NORTH PLAINFIELD, N. J.

Please send me further information on Hoover Motors. I am particularly interested in motors for

_____
(Indicate type of equipment)

Name _____

Company _____

Address _____

City _____ **Zone** _____ **State** _____

Firestone ANNOUNCES A NEW HIGH IMPACT

RESIN

with optimum properties at minimum cost

EXON 872

Exon 872—the latest result of Firestone's laboratory development program—is a pure resin, composed of tough, rigid modified styrene alloy. This new resin has exceptional physical properties and costs less than resins of comparable quality.

Exon 872 can be easily compounded and processed—readily calendered, compression or transfer molded. Products made from **Exon 872** can be machined, sawed, drilled, tapped, turned, sanded and cemented. Calendered sheets can be embossed, polished, laminated and vacuum drawn in sheet or plate form. Colors can be blended directly into the formulation.

The combination of properties found in **Exon 872** makes it suitable for a wide variety of uses including hardware, electrical equipment, parts for automobiles, refrigerators, toys, radios and television sets.

For further information about **Exon 872**—or any member of the ever-growing Firestone line—write or call Chemical Sales Division.

EXON 872 CALENDERING AND LAMINATING TYPE

Average Physical Properties of Laminated Sheets*

Rockwell Hardness	R81	Izod Impact Strength, ft. lbs./in. Notched, ⅛" Bar	
Tensile Strength, psi	3400		
Elongation, %	10 to 15	+ 25°C.	5.0
Heat Distortion @ 66 psi, °C.	88 to 89	− 25°C.	2.8
Flexural Modulus, psi	2.8×10^5	Specific Gravity	1.01

*Physical properties were obtained by cutting the test specimens from laminated stock in such a manner that the length dimensions were parallel to the grain of the calendered stock.

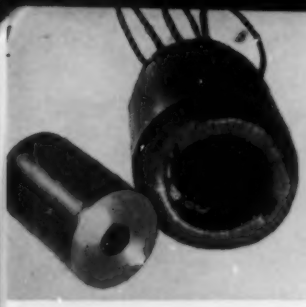
Processing Conditions:

Fusion Temp., °F.	280-300	Laminating Temp., °F.	355
Calendering Temp., °F.	340-350	Forming Temp., °F.	355

CHEMICAL SALES DIVISION

DEPT. 21P • FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA.

1



R & M Polyphase motor parts, consisting of rotor and stator, horizontal position. Light weight and reserve power for heavy duty use were the most important motor characteristics required.

2

This motor had to be lightweight, powerful and capable of running for long periods at 36,000 R.P.M. It's dynamically balanced with a diamond-turned commutator and specially anchored windings.

3

This powerful R & M Motor has a high starting torque for quick response; it runs cooler than normal, it's exceptionally quiet, and it's *compact*. Extra-heavily insulated, dynamically balanced, 100% inspected.

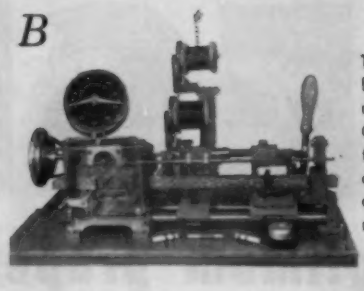
4

Variable speed was a must for this R & M Motor—to permit a wide selection of speeds without need for changing belts or pulleys. Motor is ¼ HP, AC-DC 5000 R.P.M., ball bearing equipped and open ventilated.

A

The ultra-high-speed SKIL Grinder, made by Skil Corporation, packs twice the power per pound of other grinders of similar weight. Tool and die makers say it's great!

B



The Geo. Stevens Model 125 Progressive Universal Winder made by Geo. Stevens Mfg. Co., Inc., world's largest manufacturer of coil-winding machines. One of a complete line of R & M Motor-equipped machines.

C

The powerful, easy-to-handle Buckeye Hi-Frequency Sander. It's ideal for automotive and industrial applications where tools are subjected to continuous, heavy duty service. R & M furnishes motors to Buckeye Tools Corporation in capacities from 3/16 to 4 HP.

D

The IBM Executive made by International Business Machines Corp., the only typewriter manufacturer exclusively producing electric machines. It's the mark of a modern office!

Can YOU match these motors to these tools and machines?

Here are some R & M fractional horsepower motors, and the machines for which they were selected or designed. Can you guess which goes with which? The answers are printed at the right . . . what was *your* score?

THE ANSWERS

R & M motors and motor parts, and the machines on which they are specified as standard, match up as follows:

1-C 2-A 3-D 4-B

ON COMPLETE MOTORS OR MOTOR PARTS . . .

Don't "guess" . . . let Robbins & Myers do a *scientific* job of matching the all-important motor to your product! Regardless of whether you need a motor that's standard or custom-designed . . . motors with special housing designs or motor parts to fit your housings, remember that R & M Motors are powering all types of equipment, such as . . . . . .

Portable Saws
Drills
Nut Setters
Hammers
Routers
Screw Drivers
Hedge Trimmers
Lawn Mowers
Nibblers
Lock Mortisers
Valve Grinders
Vacuum Cleaners
Files
Sanders
Pumps
Compressors
Hones
Business Machines
Cast Cutters
Food Mixers
Polishers
Planers
Portable Grinders
Sirens
Hair Driers
Advertising Devices
Ventilating Equipment
Oil Burners
Surgical Instruments
Grease Guns
Vibrators
Die Sinkers
Waxers

why you get better performance from a Fractional Horsepower Motor that's matched to your machine!

The most important single factor in the performance of any motor-driven product is the *motor itself*. That's why the engineers who designed the well-known tools and machines at the left came to Robbins & Myers to get the *right motor for the job.* Like many other R & M customers, they knew that the motor which met *every requirement*—one by one—was bound to improve the performance of their products, and *last longer* as well.

Selecting such a motor isn't simple. You can, of course, *look* at these examples, and try matching the motor to the machine for which it was designed. It's easy to guess, but in your business you can't afford guesswork.

Neither can we. That's why we've set up such systematic methods for designing motors. For example, we often use the R & M "Electrical Slide Rule." In this unique machine we first set up the electrical equivalents of motor *operating conditions;* then test equivalents of various motor *designs.* Result? Required motor characteristics can be calculated in minutes instead of days!

In some cases, the answers point to a standard motor. We have many such motors to choose from. But in other cases where special motors are indicated, we can do a fast, thorough, economical job of custom-designing a motor that's *exactly right* for your product.

In short, our experience—and our approach to your problem—isn't limited to standard motors we have "on the shelf."

If you feel that the motors you're now using aren't 100% right—in quality or in performance characteristics—we can make a real contribution to the solution of your problem. Use the coupon below . . . you will get the information you want promptly.

if it's an R&M it's the Right Motor!

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

ROBBINS & MYERS, INC., MOTOR DIVISION, SPRINGFIELD 99, OHIO: PD-103

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 125 HP
- ☐ Please have a Motor Specialist call

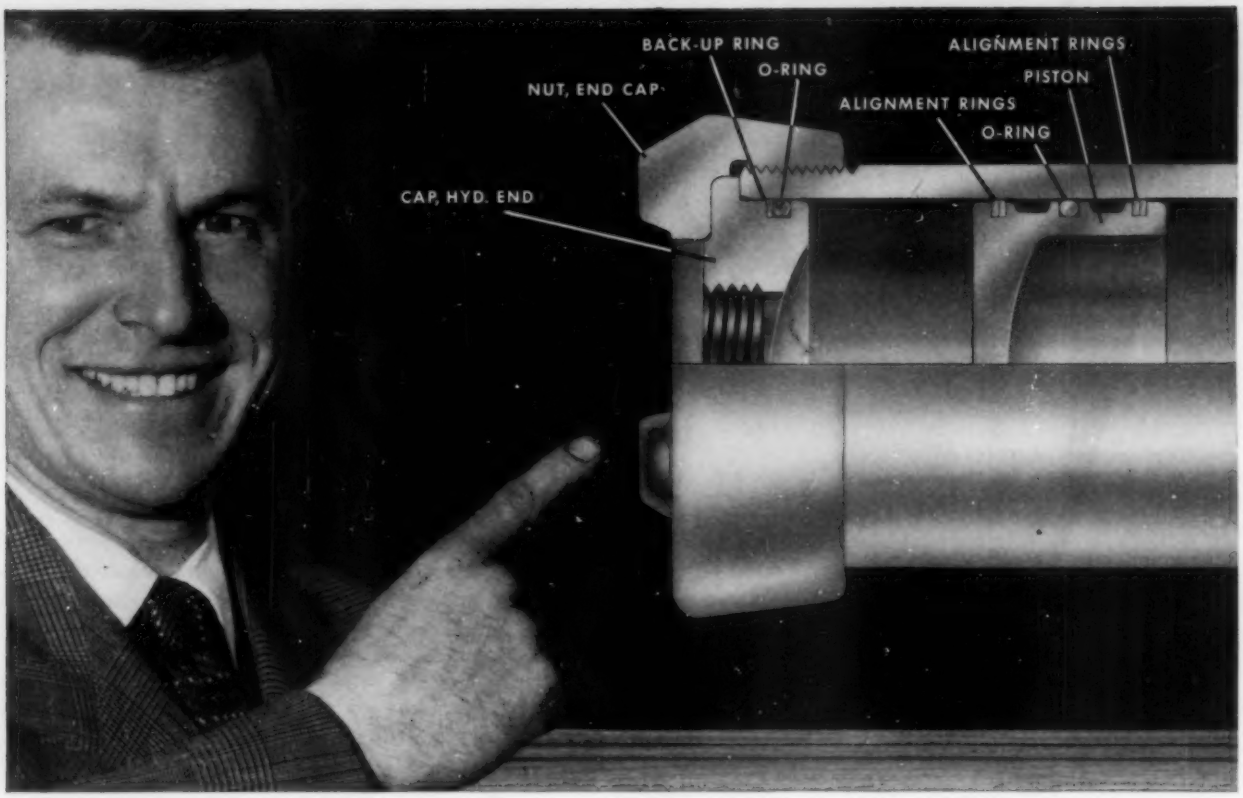
Product we manufacture: _____

Name _____ *Title* _____

Company _____

Street _____

City & State _____



Introducing new Parker

Unique design avoids wear and maintenance, provides longer life than other types

Here at last is an industrial hydraulic accumulator that provides a longer life than conventional types.

As you see in the cutaway, construction is simple. The shell is corrosion-resistant alloy steel; the piston is aluminum. Wiper alignment rings support the piston. O-rings are used only to seal fluid and pressure. This unique design reduces frictional wear to a minimum.

The new Parker accumulator is designed for greater safety, too. During dismantling, a safety vent in the end cap warns of trapped gas pressure. It allows this pressure to escape before the end cap is removed completely.

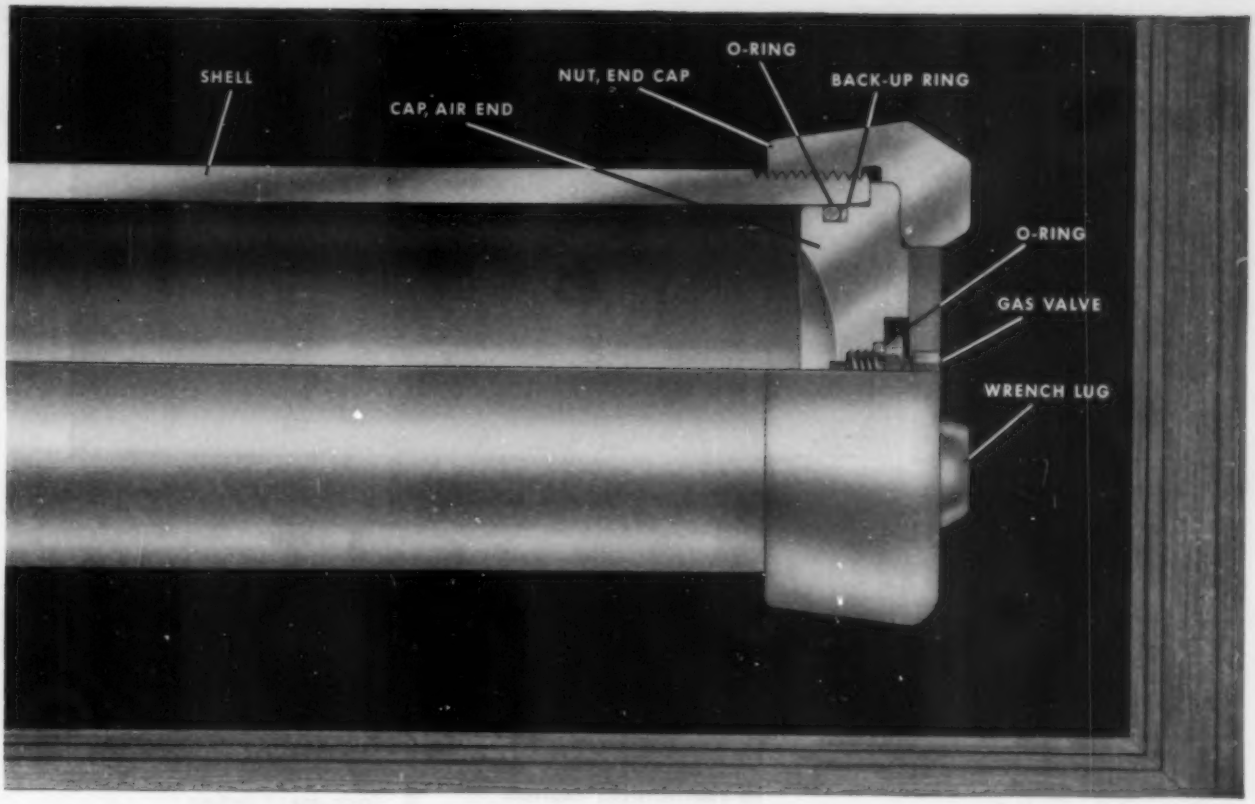
This new accumulator is offered in eleven sizes. Lengths vary from 9⅜ to 40 inches. Inside diameters are 1½, 4, or 7 inches. Oil volume capacities range from 10 to 1155 cubic inches. Maximum operating pressure rating is 3000 psi.

Also, for accessory use with accumulators, Parker offers a complete line of quick-opening, no-chatter check valves.

If you're not using accumulators, you'll find they can greatly simplify hydraulic system design, providing a means of steady power and saving wear on pumps. For information, mail the coupon.

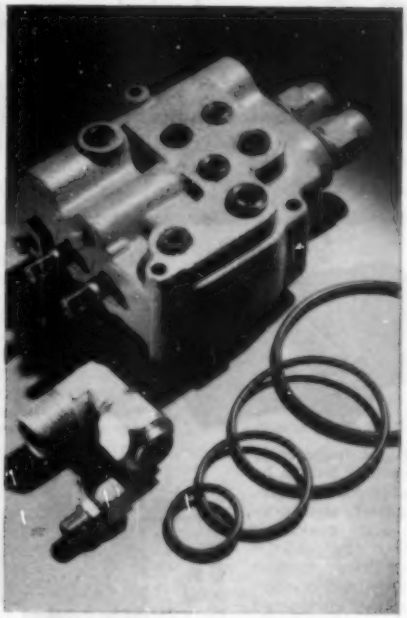
INDUSTRIAL HYDRAULICS DIVISION
The Parker Appliance Company
17325 Euclid Avenue, Cleveland 12, Ohio

Parker
Hydraulic and fluid system components



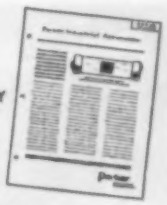
piston-type accumulator

100% safety tested on stands like this, all Parker industrial accumulators are checked at hydraulic pressures up to as high as 10,000 psi.



What other Parker products for hydraulic and fluid systems interest you? Triple-lok flare fittings? Ferulok flareless fittings? Synthetic rubber O-rings? Any other products?

THE PARKER
APPLIANCE COMPANY
Section 202-L
17325 Euclid Avenue
Cleveland 12, Ohio



Please send the following:

☐ Accumulator Catalog File 1536A

☐ Catalogs describing these other Parker product:_____

_____

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

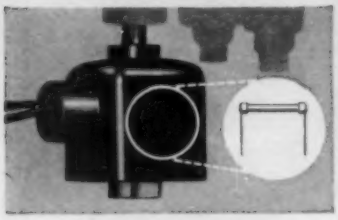
CITY_____ STATE_____

Mail this coupon for technical information about Parker's trouble-free accumulator. If you'd like to know more about other Parker products, list them on the coupon.

(Advertisement)

News About Created-Metals

Thermistors Provide Vital Time Delay

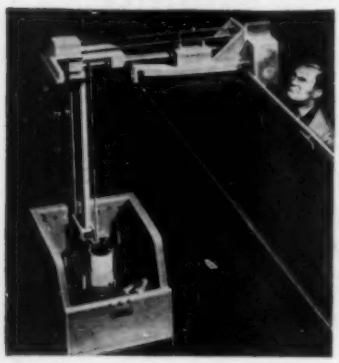


Smoky starts, puff-back and flutter in oil burners were checked by using a Carboloy Thermistor in the burner's electrical control.

The Thermistor delays the opening of a solenoid valve until the combustion chamber is ready to receive properly aerated oil. A mechanical timer is eliminated, and the cost of the unit reduced.

Thermistors are the most thermally sensitive resistor material known. Their resistance – unlike metals – changes negatively with temperature increases. They are ideal for temperature compensation, temperature detection, warning devices and controls. For more information, write: Carboloy Department of General Electric Company, 11127 E. 8 Mile Ave., Detroit 32, Michigan.

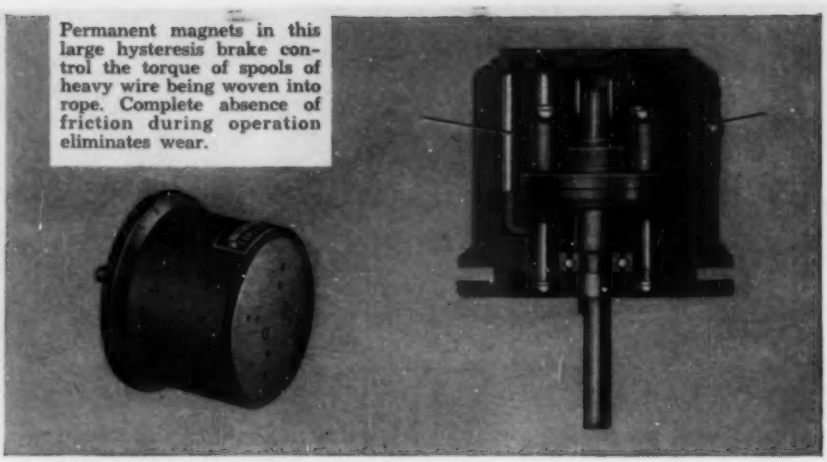
Hevimet Containers Stop "Hot Atoms"



Containers made of Carboloy Hevimet are making the job of handling and transporting radioactive materials easier and safer.

Because Hevimet is almost 50% heavier than lead, and provides 40% more gamma ray protection, these containers are smaller, less bulky . . . yet safer than lead.

Hevimet is an ideal material for all radioactive shielding. It is readily machinable, dimensionally stable and of high tensile strength. For more information, write: Carboloy Department of General Electric Company, 11127 E. 8 Mile Ave., Detroit 32, Michigan.



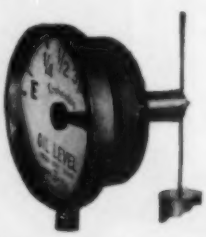
Permanent magnets in this large hysteresis brake control the torque of spools of heavy wire being woven into rope. Complete absence of friction during operation eliminates wear.

Control Torque

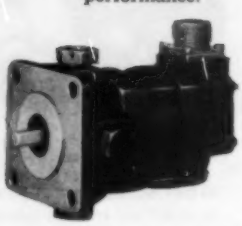
Basic functions of permanent magnets

1	Change electrical energy to mechanical motion	Eddy current braking Motor action Instrument action
2	Change mechanical motion to electrical energy	Generator action Magneto action
3	Change mechanical energy to thermal energy	Control of torque
4	Mechanical holding	Snap action Separation Holding and lifting

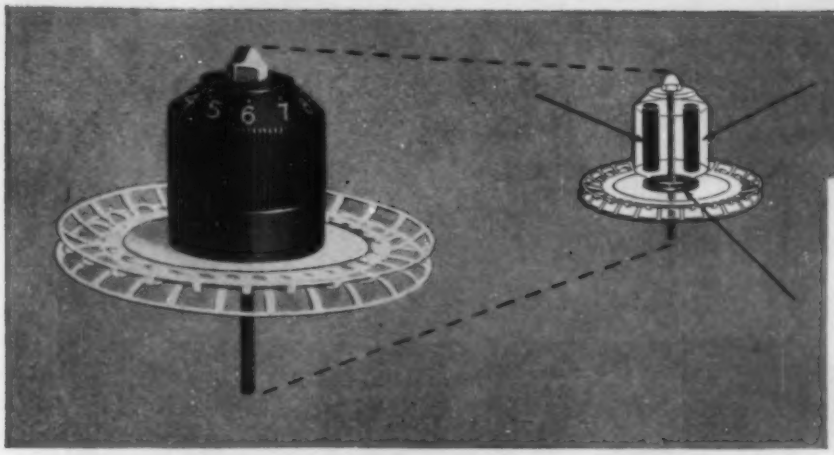
Minneapolis-Honeywell Step Controller employs snap switch based on mechanical holding function of Carboloy Alnico permanent magnets. Magnets reduced weight, improved design, and increased performance.



G.E. jet tachometer generator had to be kept small and light. Engineers used permanent magnet's ability to change mechanical motion to electrical energy. Magnets eliminated coils and wires; provided powerful energy.



Rochester Liquid Level Gauge utilizes synchronous magnetic torque drive principle to operate pointer, keep gauge head pressure-tight. Magnets eliminate stuffing box and shaft – permit mounting gauge in any position without danger of leakage.



This tiny, permanent magnet hysteresis brake maintains constant pulley tension on delicate fibers. It reduces slippage and static electricity. Magnetic dial offers wide range of tensions and speeds.

with Permanent Magnets

In hysteresis brakes, permanent magnets convert mechanical energy to thermal energy. Other inherent properties make permanent magnets ideal for many electrical and mechanical applications.

Carboloy Alnico permanent magnets, in hysteresis brakes, provide smooth, frictionless torque control. Tension and torque are adjustable and constant.

The hysteresis brake is only one of the ways permanent magnets can control torque. And permanent magnets can be used to convert electrical energy to mechanical motion . . . or mechanical motion to electrical energy, or for mechanical holding.

Permanent magnets offer many production savings. They can eliminate parts, reduce costs, simplify design, save weight and improve performance. They retain their efficiency under varying conditions of temperature, shock, vibration. They resist the demagnetizing influence of stray magnetic fields . . . provide powerful, permanent energy sources. Available in all sizes and shapes, cast or sintered.

Perhaps Carboloy permanent magnets can improve your products or equipment. Specially trained engineers of the Carboloy Engineering Appraisal Service will work with you on permanent-magnet design and application. Send coupon, today, for free catalog or design manual.

"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

CARBOLOY®
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11127 E. 8 Mile Ave., Detroit 32, Michigan

Send me the following, without cost or obligation:

- ☐ Permanent Magnet Design Manual, PM-101
- ☐ Permanent Magnet Standard Stock Catalog, PM-100

Name _____ Position _____

Company _____

Address _____

City _____ Zone _____ State _____

KLIXON PROTECTED MOTORS

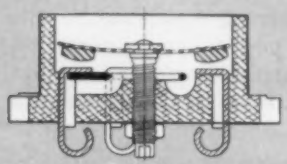
...used for over 15 years on "TACO" Water Circulating Pumps to assure dependable operation

Illustrated is a Taco Water Circulating Pump manufactured by Taco Heaters Incorporated, Providence, R.I. The motors used in these units have built-in Klixon Protectors to prevent motor burnouts. Here's what Mr. R. T. Schoerner, Chief Engineer, has to say about Klixon...

> "We have been using motors equipped with Klixon Overload Protectors on our circulating pumps for more than 15 years. We have found these protectors to be unusually dependable for this tough service."

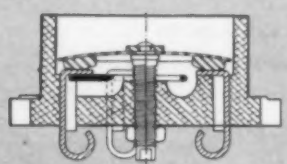
As a user of electric motors, you can keep your equipment operating, cut motor repair and replacement costs by using motors with built-in Klixon Protectors. The additional cost is low... pays for itself in short order.

HOW KLIXON PROTECTORS PREVENT MOTOR BURNOUTS



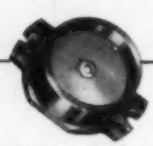
CLICK... IT'S OFF!

When the temperature within the motor reaches the danger point, the Klixon Protector snaps the power "OFF," prevents a burnout.



CLICK... IT'S ON!

As soon as the motor cools to a safe operating temperature, the Klixon Protector automatically snaps the power "ON" again... or by pushing the red button when the manual reset type is used.



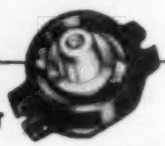
Automatic Reset

KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corporation

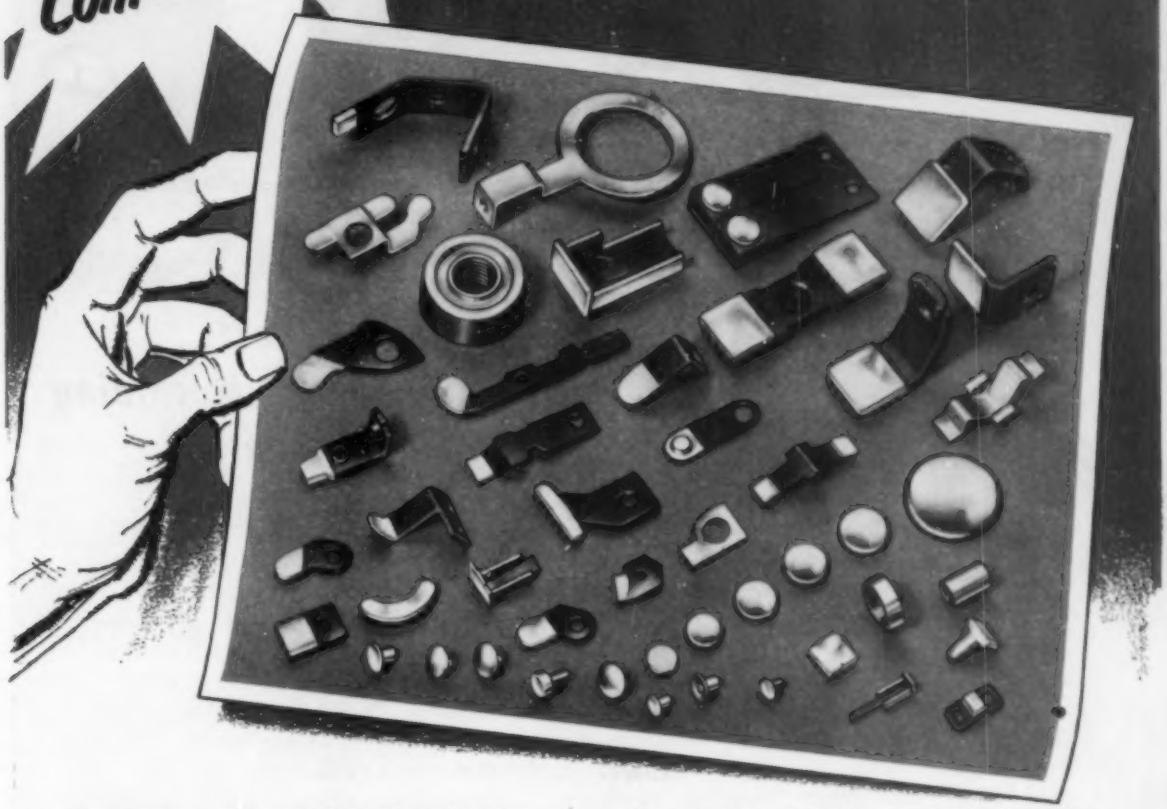
902 FOREST ST., ATTLEBORO, MASS.



Manual Reset

Here's a Way to Cut Contact Costs

YET MAINTAIN
High Performance Quality
...USE
GENERAL PLATE
Composite Contacts



Illustrated are typical fabricated composite contacts and assemblies accurately manufactured to customers' specifications by General Plate from General Plate Composite contact material.

As pioneer manufacturers of composite strip, overlay, edgelay and Top-Lay contact metals, you are assured of the highest quality raw materials. Add to this the know-how of fabrication of these composite metals and you are assured of contacts that give you positive performance and long life.

In addition, by letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble . . . needless equipment cost and problems of scrap disposal are eliminated . . . contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

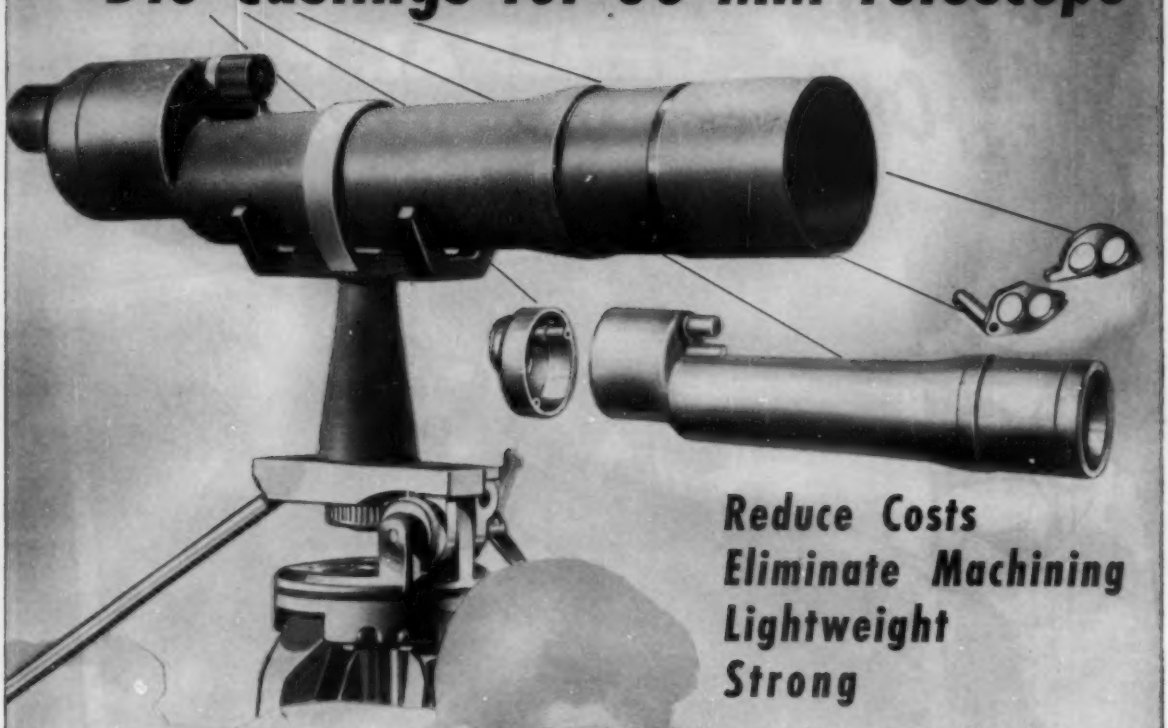
General Plate Palladium or Palladium Alloy Rivets, solid or composite, offer high resistance to tarnish and corrosion coupled with low and uniform contact resistance over long periods of time. When made as a composite rivet or part — palladium bonded to a base metal — they reduce costs because they permit the use of a minimum amount of noble metal. The palladium provides the necessary contact surface, the base metal reduces costs.

Write for complete information and catalog PR700.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
12 FOREST STREET, ATTLEBORO, MASSACHUSETTS

BAUSCH & LOMB selects PARKER Die Castings for 60 MM Telescope



Reduce Costs
Eliminate Machining
Lightweight
Strong

Bausch & Lomb, now celebrating its 100th anniversary, selects Parker as source for quality die castings. The product illustrated is the Bausch & Lomb BALscope Sr. 60 MM spotting scope in wide use as a shooter's spotting scope or, when mounted on a tripod, a telescope for astronomy, sports or bird watching. Parker Die Castings, component parts of this high precision scope, serve to reduce costs by elimination of machining operations. The parts are produced to rigid specifications . . . lightweight and strong.

Consult with Parker on your next die casting requirements. Your action will be mutually profitable.

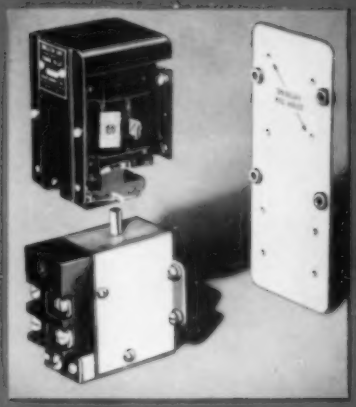
and when you think of Die Castings THINK OF

Parker White-Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER ALUMINUM *and* ZINC *Die Castings*

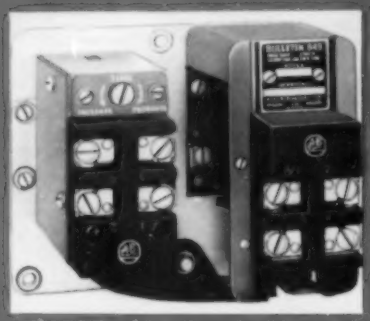
BULLETIN 849 TIMING RELAY CONSISTS OF TWO UNITS

The solenoid operating unit and the pneumatic timing unit are mounted on a steel backplate.



ON-DELAY OR OFF-DELAY

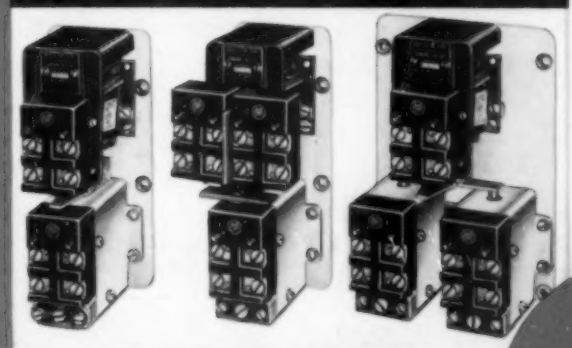
The timer may be arranged for ON-Delay or OFF-Delay. ON-Delay provides time delay when solenoid is energized; OFF-Delay provides time delay when solenoid is de-energized.



HORIZONTAL CONSTRUCTION

Style ZAX Pneumatic Timer is available for applications in which the horizontal arrangement of solenoid and timing unit satisfies space requirements better than the vertical type.

AVAILABLE IN MANY CONTACT COMBINATIONS



A great variety of contact arrangements can be provided for Bulletin 849 Timers, as shown in the illustrations above. Full details concerning contact arrangements furnished on request.

BULLETIN 849 PNEUMATIC TIMING RELAY

Solenoid Operated

EASY TO ADJUST

for Timing Intervals from 10 Cycles to 3 Minutes

Here is a compact . . . easy to adjust . . . solenoid type pneumatic timer with quick make-and-break silver alloy contacts that operates with an accuracy of ±10% . . . irrespective of temperature, humidity, or vibration. Its wide timing range . . . from 10 cycles to 3 minutes . . . makes it the ideal timer for hundreds of industrial applications.

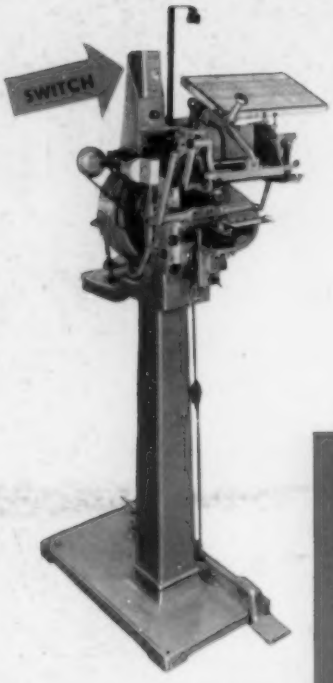
There are one set of normally open and one set of normally closed contacts. Additional contacts may be mounted on the timer frame and actuated by the same solenoid mechanism. Wiring terminals are all accessible from the front. Send for illustrated Bulletin 849, today.

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.

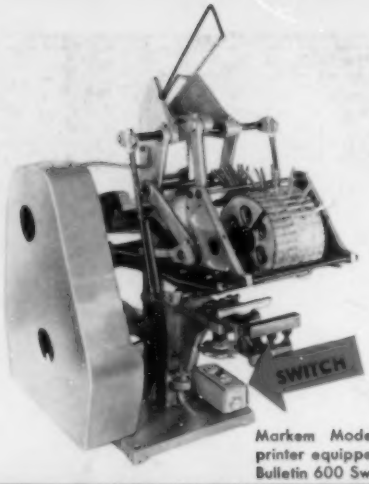
A-B Quality

ALLEN-BRADLEY
QUALITY
TIMING RELAYS

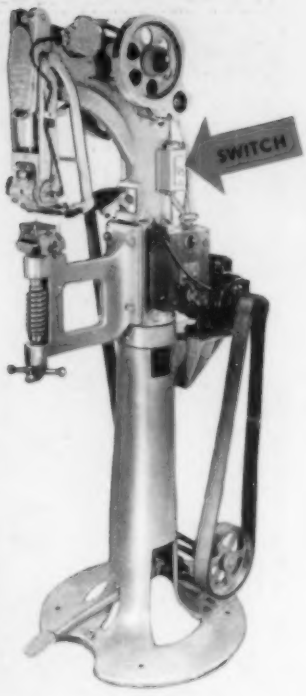
2-54-R



Markem Model 105 heavy duty box and label printer equipped with an A-B Bulletin 600 Manual Starting Switch.



Markem Model 45AC printer equipped with a Bulletin 600 Switch.



Markem No. 2 embosser for indenting and coloring on plastics, wood, leather, etc., with A-B Bulletin 600 Switch.

SNAP SWITCH *with* OVERLOAD BREAKER FOR 1 HP MOTORS AND SMALLER

● Burnouts of small motors can often cause serious production delays. Therefore, dependable overload protection is absolutely essential . . . and for motors of 1 hp or less the Allen-Bradley Bulletin 600 Starting Switch is the logical answer.

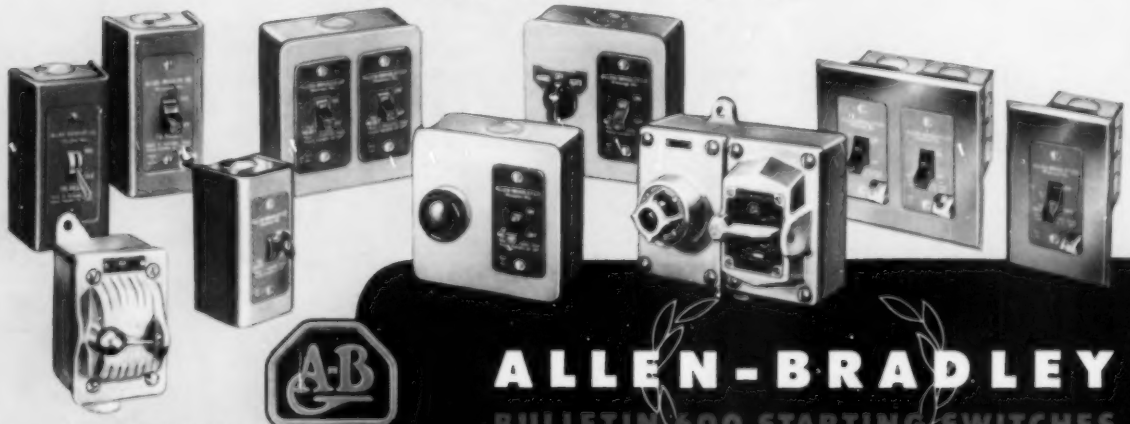
It has a built-in thermal overload breaker which trips the toggle switch in case the motor is overloaded . . . and you can't keep the switch closed until the overload on the motor is cleared.

The Bulletin 600 Manual Starting Switch is ideal for small a-c and d-c motors on space heaters, stokers, refrigeration compressors, fans, pumps, packaging machines, labelers, grinders, and other light machinery.

Available in open type construction and also in standard sheet metal enclosures, waterproof and weatherproof enclosures, and gastight enclosures for installations in hazardous gas locations.

Bulletin 600 Manual Starting Switches can be furnished in various auxiliary combinations—namely, with pilot lights, selector switches, and key and lever switches, as illustrated below. They will fit into standard conduit switch boxes if desired. The double break, silver alloy contacts need no attention. Bulletin 600 gives dimensions and other data.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.



A few examples of the variety of enclosure combinations in the Bulletin 600 Manual Starting Switch line.

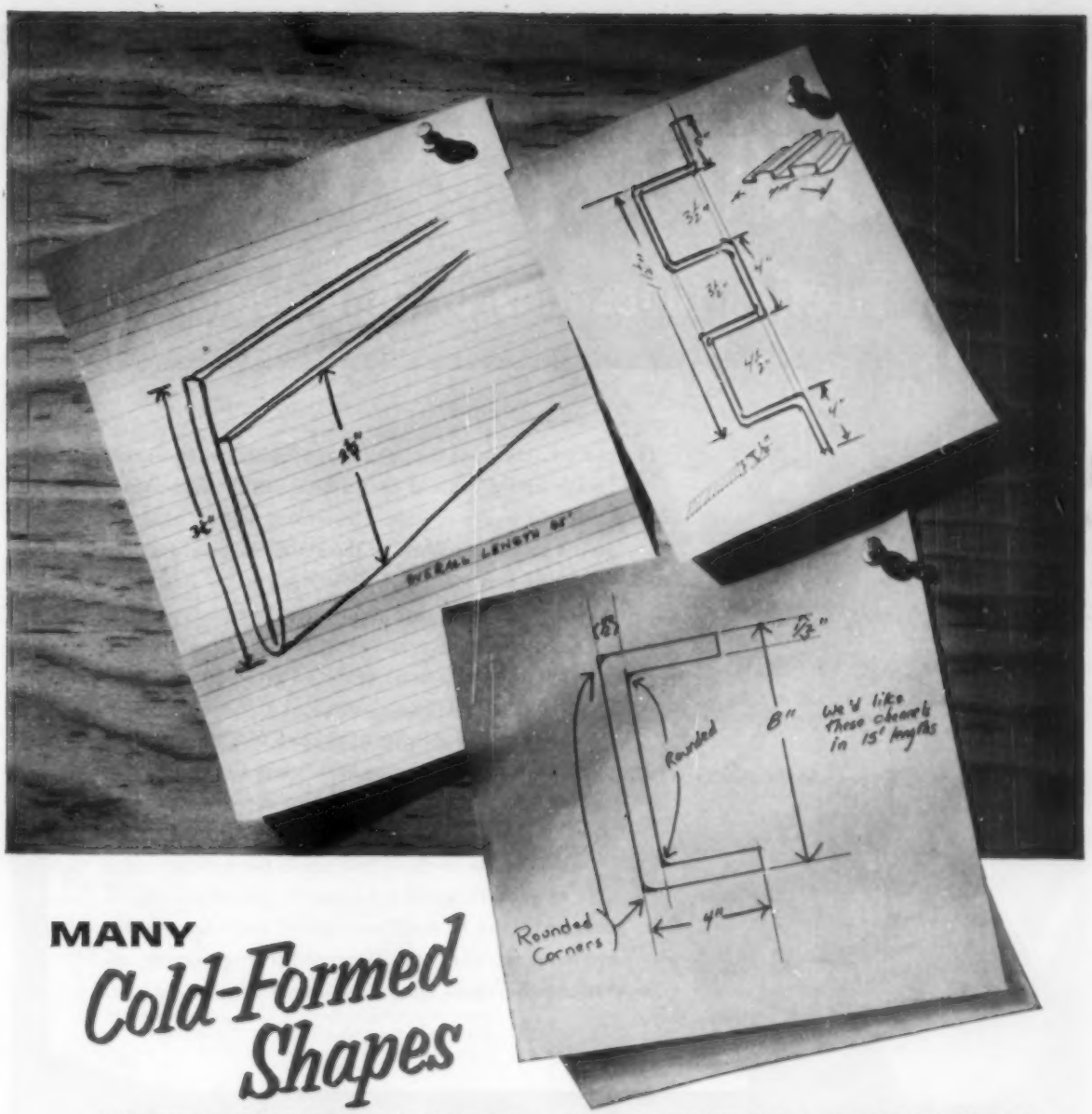
A-B Quality

ALLEN-BRADLEY

BULLETIN 600 STARTING SWITCHES

QUALITY

2-54-MR



MANY *Cold-Formed Shapes* ORIGINATE WITH A SIMPLE SKETCH

The most simple of pencil sketches, submitted with your inquiry, can be the start of a new cold-formed shape which can be put to work advantageously, either as a part for your new product, or as an improvement for an existing product.

We submit such sketches to our experienced sales engineers for study. Very often they can suggest modifications which permit more economical production on our specialty equipment.

For cold-formed shapes can be so greatly varied. Among the hundreds we've turned out recently are such diversified items as sign supports, curtain tracks, rub rails for bus bodies, sections for radiant baseboards, and parts for storage racks and lawn mowers.

Bethlehem Cold-Formed Shapes are regular or irregular shapes formed cold from strip, sheet or plate steel. They are uniform in thickness, with a surface that's relatively free from scale. They have a high strength-to-weight ratio. We turn them out on presses, brakes or rolls in all gages from 5 to 24, and in virtually any length.

Perhaps you have an idea which could be developed into a practical, cost-cutting use for cold-formed shapes. If so, tell us about it. Write direct to us at Bethlehem, Pa., including if possible, a rough sketch of the part you have in mind.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

NOW

LABORATORY TESTED

for meeting thousands of rigid demands...

The remarkably wide range of uses to which components made and processed by Western Felt is astonishing. It is serving in scores of industries—from women's hats to 50 ton forge hammers. In the automobile field alone, as an example, this felt has been chosen to best serve in more than thirty purposes per car.

Western Felt engineers and chemists for decades have worked in close cooperation with users of felt to give them the very highest quality of material, exactness and uniformity. There are still a world of potential uses for Western Felt products, made to almost any shape, size or consistency. They range from wool-softness to rock-hardness. When cut, it does not fray or lose shape. It can be cut to close tolerances for such products as gaskets, washers, channels, grommets, filters, seals, etc. It can be made waterproof and fungus-proof and flame resistant. Ask Western Felt engineering co-operation—they have specialized knowledge to aid you.

Sheet and roll felt manufactured for special purposes and to meet all S.A.E. and military specifications.

WESTERN Felt WORKS

4033-4117 Ogden Ave.
Chicago 23, Illinois
Branches in all Principal Cities

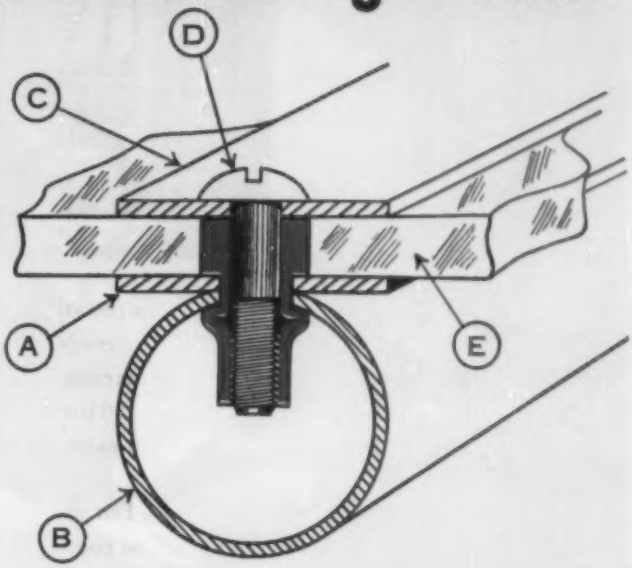
MANUFACTURERS AND CUTTERS OF WOOL FELTS

B. F. Goodrich **RIVNUTS** fasten plastic to tubular post, make weather-tight seal!

TO PROVIDE a neat, tight seal for airplane windows, designers needed a simple, one-piece fastener—a blind rivet and nut plate combined. They found the ideal answer in a spacer-head B. F. Goodrich Rivnut.

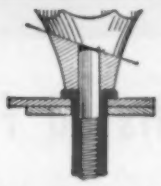
With the easy-to-use heading tool, one man quickly upset the Rivnut, securely riveted plate "A" to tubular center post "B". The firm bulge formed in the Rivnut shank conformed to the curvature of the tube. The Rivnut head served as a spacer for transparent plastic sheets "E". Screw "D" was then threaded into the clean, still-intact Rivnut threads to hold clamp strip "C" and plastic sheets in place.

Besides providing a tight, dependable seal, Rivnuts saved many man-hours on this job. If you're looking for a fastener which can improve your product and cut production time, why not get the facts from a Rivnut engineer? Write The B. F. Goodrich Company, Department PE-24, Akron, Ohio.

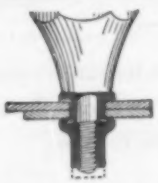


Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.



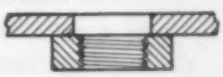
3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

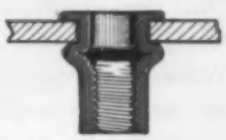
Compare these 4 methods of putting screw threads in thin sheet metal

Tapped—2 threads

Pierced and tapped—3 threads



Projection welded—4 threads



Rivnut—at least 6 threads

B.F.Goodrich RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Co., Dept. PE-24, Akron, Ohio.

"Let's be sure they're listed for all 3"

"Check your records, Miss Webster, to be certain we have Wolverine listed as a supplier of copper, aluminum, and electric-welded steel tubing.

"That gives us a single source for the three kinds of tubing we use here. Oh, yes, make a note that Wolverine can supply us with technical help. They tell me up in engineering that Wolverine has smoothed out some rough spots for them on the last job."

It's in the cards: Make sure that Wolverine is in your files as a one-source supplier of copper, aluminum or electric-welded steel tubing. And make sure that you address your company's technical problems to Wolverine's Field Engineering Service.

If you want capsulized, helpful information—send for Wolverine's handy Statement of Scope. It tells at a glance what Wolverine can do for you.

And make sure you give this memo to your secretary today—WOLVERINE TUBE DIVISION, of Calumet & Hecla, Inc., 1479 Central Ave., Detroit 9, Michigan.

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OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing

MEMO: *"Make sure that Wolverine is listed for all 3—tubing of copper, copper base alloys, aluminum and electric-welded steel."*

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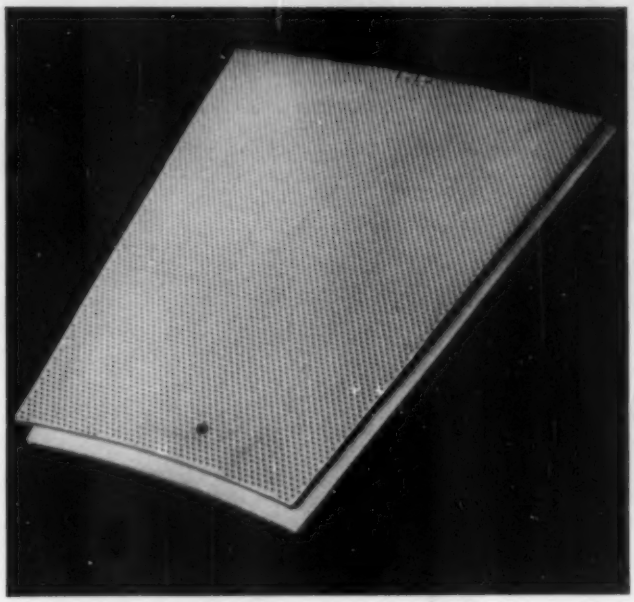

← **IMPROVED DESIGN AND MATERIAL**—The tiny needle-sharp points covering this plate must resist severe abrasion. Machined points used to wear out frequently because they were pyramidal in shape and highly susceptible to erosion. HAYNES investment casting made it possible to cast the points in a more stable conical shape from a hard, wear-resistant alloy. Life has been increased by 5 to 12 times.

EXCELLENT SURFACE QUALITY—For sanitary reasons, not even the smallest crevice can be tolerated on this cream separator part. Because of the high quality of HAYNES investment castings, it was found that the intricate part could be manufactured on a production basis with a minimum of imperfections showing up during the final polishing operations. This eliminated a great deal of wasted time, work, and metal.

NO MORE MACHINING—HAYNES investment casting eliminated the job of machining these rollers. Service conditions require that the rollers be made of a special alloy which is difficult to machine. They must resist rusting and the cutting action of wire passing over them under tension. The rollers give excellent service life and there are no more machining problems.

HAYNES investment castings can solve some of your own production and design problems. For more information, contact the nearest Haynes Stellite Company office listed below.

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

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Sound, dense, high-strength parts available in cobalt-base alloys, nickel-base alloys, iron-base alloys, stainless steels, and alloy and carbon steels.

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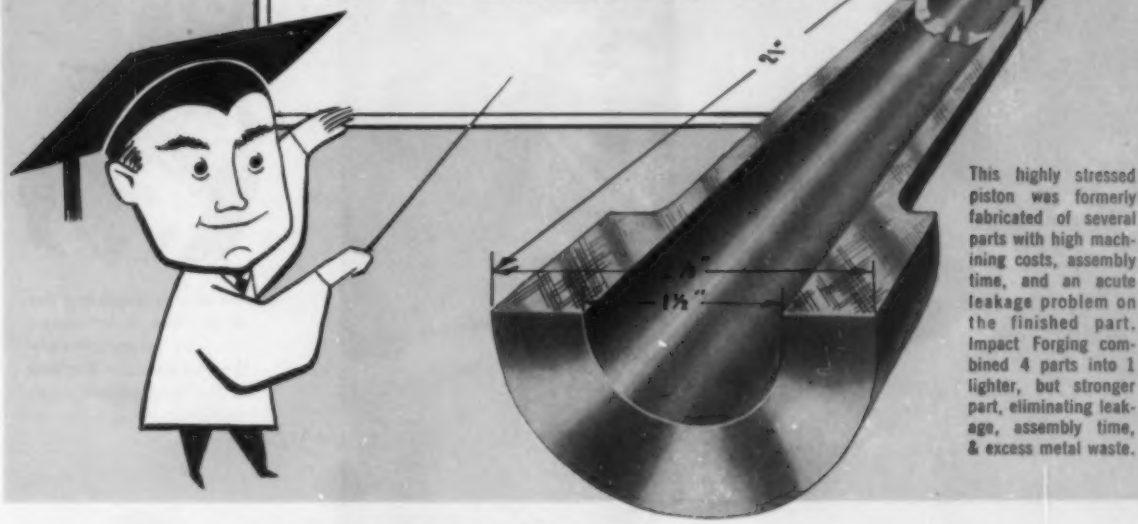
Mr. Design Supervisor

...an equation you should know

$$HD^2+IF^3=SP^*$$

*Hunter Douglas + Impact Forging = Simplified Production



This highly stressed piston was formerly fabricated of several parts with high machining costs, assembly time, and an acute leakage problem on the finished part. Impact Forging combined 4 parts into 1 lighter, but stronger part, eliminating leakage, assembly time, & excess metal waste.

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FROM

HIGH STRENGTH ALUMINUM ALLOYS

Impact Forging is a mass production method of shaping high strength aluminum alloys by direct compression. This new production technique, perfected by Hunter Douglas, permits the use of heat treatable aluminum alloys in applications formerly designed to steel. Combined with the strength-weight ratio of aluminum, Impact Forging develops a forged grain flow to obtain maximum strength in each part.

Impact Forging can often produce the same part in one operation that formerly required multiple machining, and produce as a single piece a part that under ordinary methods required a number of smaller pieces assembled by threading, welding, or other secondary operations.

If you are designing a part for mass production with close dimensional tolerances and micro-precise surface finish, Impact Forging can be your answer. Hunter Douglas has had a vast amount of experience in making millions of high strength aluminum alloy forgings with great economies through simplified design. Find out how you can design for Impact Forging in place of machining, drawing, forging or casting. Forward your blueprints, specifications, or sample parts and let the Hunter Douglas engineering staff give you their analysis.

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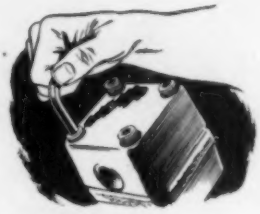
Four UNBRAKO Socket Head Cap Screws speed assembly in the plant, and reassembly in the field, of these flow-control valves providing 16 different inlet-outlet flow direction combinations.

The knurling on the head of the screw permits faster assembly, because it provides a slip-proof grip.



The uniform depth and size of the hex socket assure maximum torque in wrenching. The accurate diameter of the head permits countersinking.

UNBRAKOs—made of heat treated alloy steel—have fully formed threads, Class 3 fit; controlled fillet and continuous grain flow for strength. Supplied in standard sizes from #4 to 1".

Get personalized service, faster delivery with UNBRAKO Standards—stocked by your distributor

When you use UNBRAKO socket screw products, you get the finest socket screws made, *plus* the personalized service and the faster delivery of your local distributor. And he enables you to cut your inventory, set up more space for production. For more information, write for UNBRAKO Standards—a complete listing of precision socket screw products carried by your distributor. STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION

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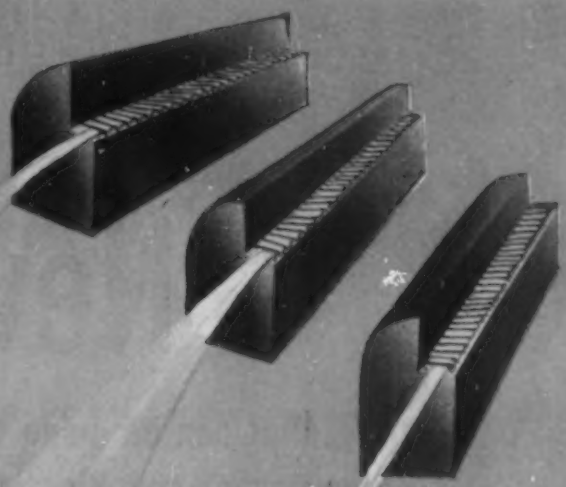
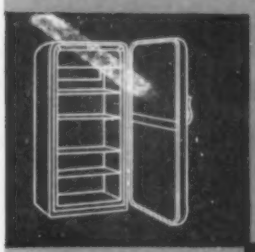


Roll Formed can help you earn a bigger profit by making your fabricated parts better, faster and more economically. Put our production facilities and knowledge of metal shapes to work for you. We can form, bend, notch and punch your parts ready for final assembly. Regardless of whether your shapes are stainless, carbon steel, aluminum or copper clad metals, we will produce them to your specifications and deliver them as your production schedule demands.
Discuss your metal shapes problems with us.
We'll show you how to solve them economically.



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It includes information about standard and special shapes, lockseam and butt seam tubing.

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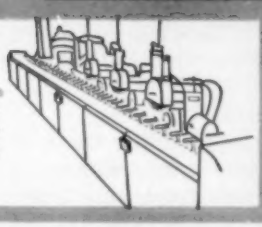
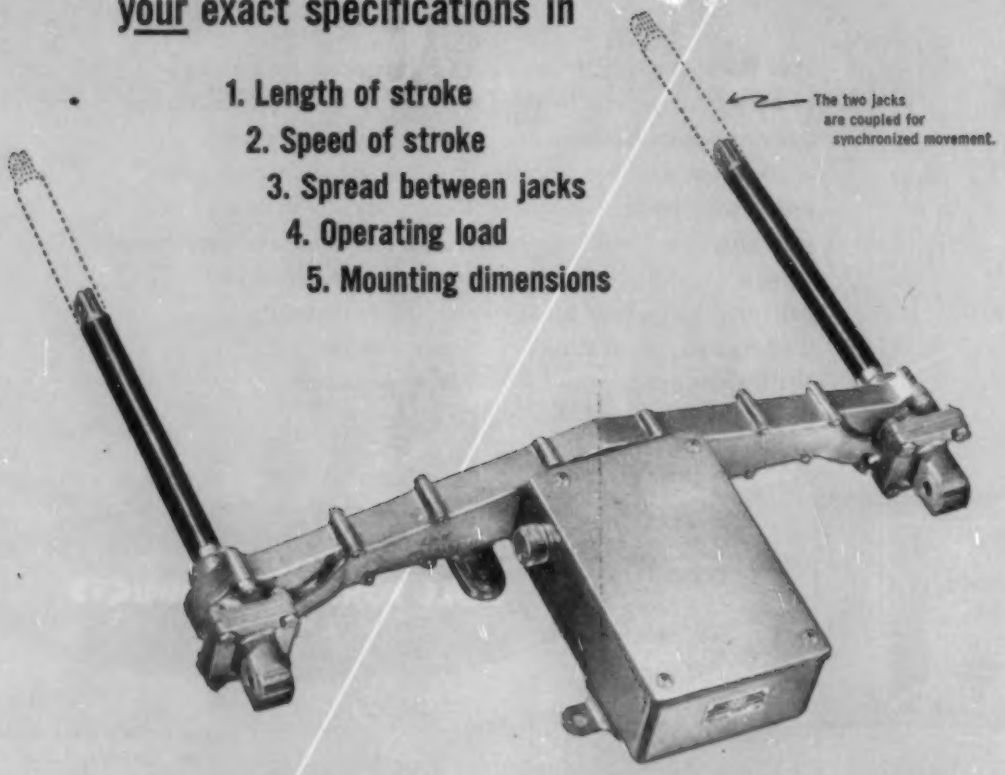


EEMCO technical bulletin

a New PILOT SEAT ACTUATOR

... that can be made to your exact specifications in

1. Length of stroke
2. Speed of stroke
3. Spread between jacks
4. Operating load
5. Mounting dimensions



Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Blvd.
Los Angeles 16, Calif.

Another new product from the design department at EEMCO is this pilot seat adjustment actuator that can be made to your exact specifications as listed above. With a weight of only 7 pounds, it will handle an operational load of 350 pounds and more. The compact control box, only 2⅜" x 4¼" x 6¼" in size, contains the small and powerful EEMCO motor for driving the two jacks, as well as the clutch, brake, limit travel switches and radio noise filter. The two jacks are coupled for synchronized movement. The actuator illustrated has the following specifications:

Operating load: 350 pounds
Voltage required: 26 DC **Amperes:** 8.5
Stroke: 4.625" **Speed of stroke:** .75" per second
Ultimate static tension load: 6600 pounds
Ultimate static compression load: 1800 pounds

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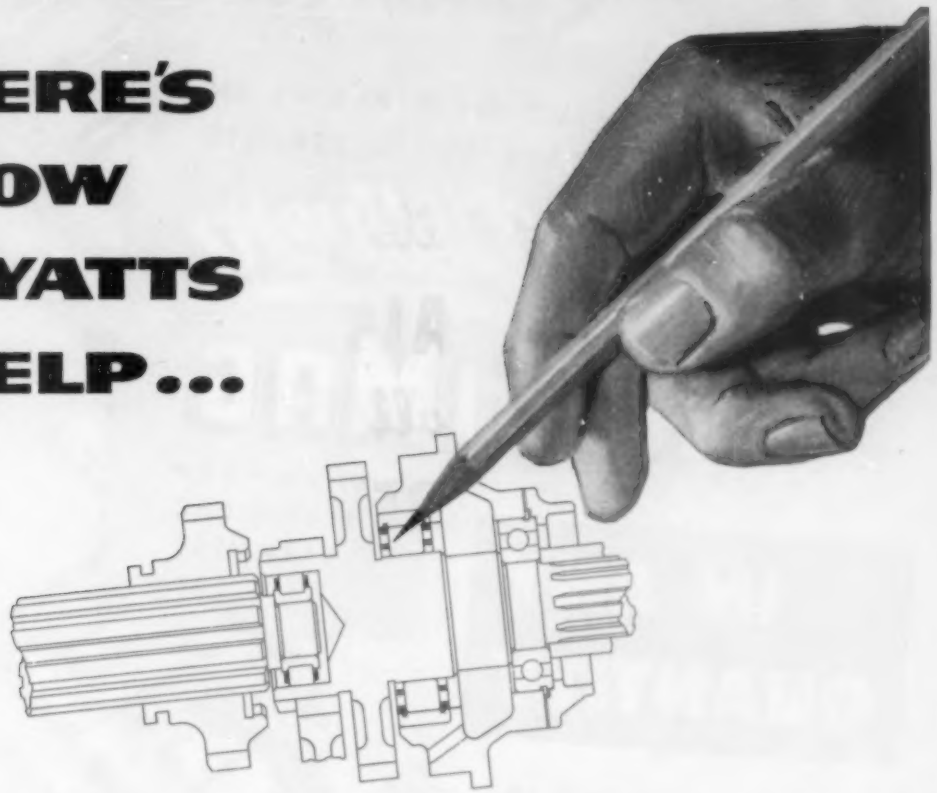
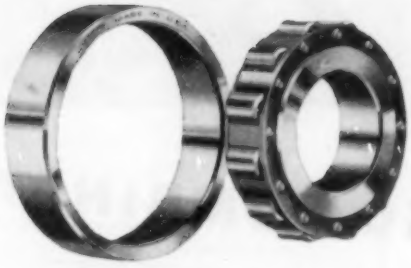
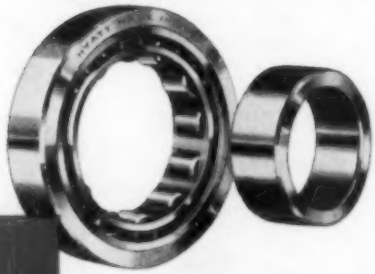
HERE'S HOW HYATTS HELP...



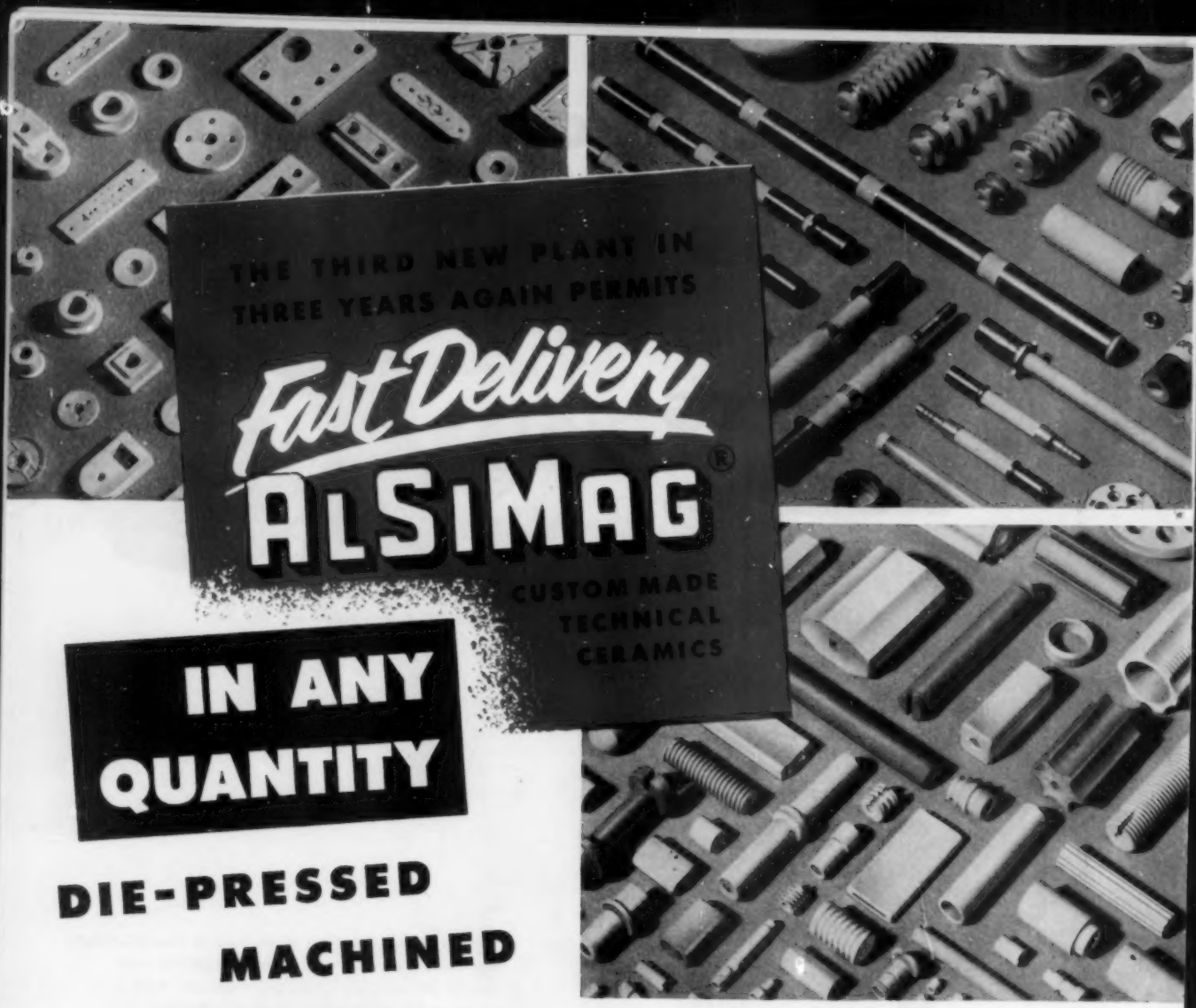




Sometimes a fraction of an inch is the difference between a simple design modification and costly re-tooling. And the engineer who is thoroughly familiar with Hyatt Roller Bearings will know a lot about how to save those fractions. He'll know, for example, that to gain greater shaft rigidity with the same size housing, he need only check his Hyatt catalog for a separable inner race type of bearing. This type—available in a wide range of sizes—may be applied with the rollers operating directly upon the surface of a suitably hardened and ground shaft. Thus, a larger-diameter shaft may be used without sacrificing bearing capacity, or a larger-size bearing may be used without changing the size of the shaft. For a copy of Hyatt's latest catalog, No. 150, write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER



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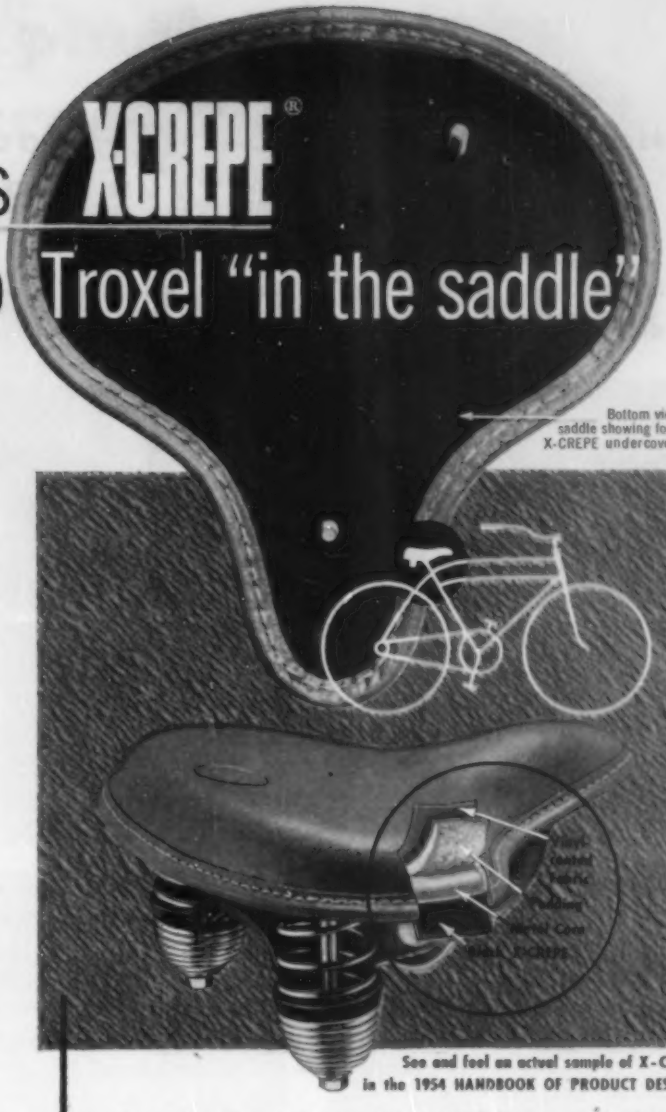
how Cindus X-CREPE® helps keep Troxel "in the saddle"



Bottom view of saddle showing formed X-CREPE undercovering.

Makes possible Custom-stitched Bike Saddles at Competitive Prices.

Style-minded bike manufacturers demanded handsome, custom-stitched bike saddles, wanted them at the *same price* as unstitched saddles. The problem: bike saddles have a metal core, and you can't stitch vinyl-coated fabric to metal. A stitchable, formable, waterproof undercovering was the only answer.

Troxel Manufacturing Co., "the finest name in saddles," experimented with vinyl-coated fabric and other similar materials, but found they were too costly.

Then Cindus product engineers recommended a waterproof grade of X-CREPE. It's formable, stitchable, has cloth-like texture and appearance—perfect for an undercovering. And it enables Troxel to *hold the line on materials costs.* X-CREPE sews easily without pre-punching holes—gives waterproof protection to inner elements, won't deteriorate.

Troxel is "in the saddle," laps ahead of competition with this high-quality product, priced just right.

This example is typical of hundreds of cases where manufacturers have standardized on X-CREPE because it fills a wide variety of needs better and more economically than less versatile materials. We can tailor X-CREPE to fit *your* needs.

See and feel an actual sample of X-CREPE in the 1954 HANDBOOK OF PRODUCT DESIGN.

Troxel lays die-cut sheets of black X-CREPE, vinyl-coated fabric and padding into a forming press with the pre-formed metal core—then stamps all together into a saddle sandwich. X-CREPE forms readily, holds its new shape well.

Next, the saddle sandwich is stitched and trimmed in one operation. Final stitching puts an attractive binding around the edge. See for yourself what a trim, saleable saddle it makes!

® X-CREPE is the trademark of Cincinnati Industries, Inc., for its double-creped products.

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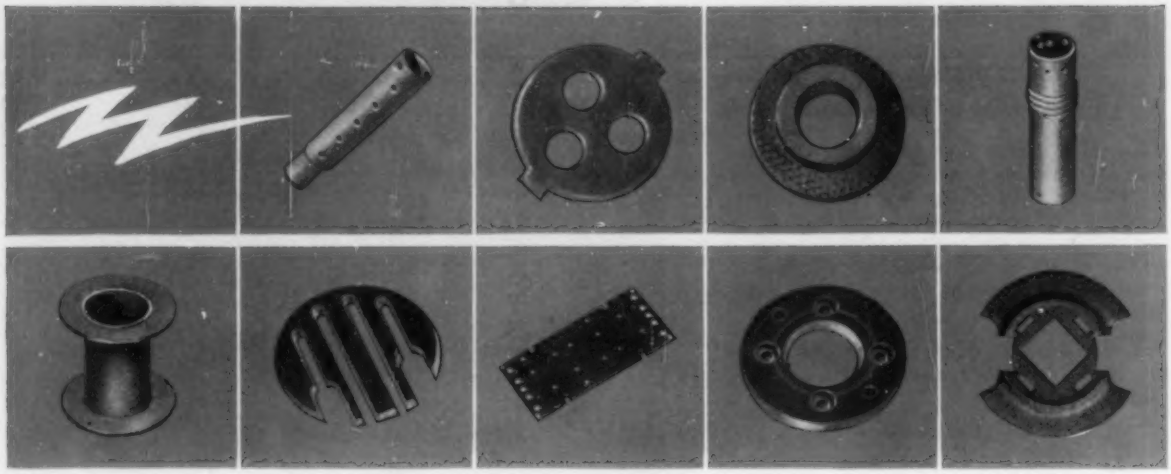

SPAULDING PRODUCTS have high dielectric strength, low loss factor, excellent arc resistance, deionizing properties, low heat conductivity, and moisture resistance.

THESE DESIRABLE electrical insulating characteristics may be had in a variety of combinations with chemical and mechanical properties such as light weight, resistance to wear and abrasion, dimensional stability, and chemical inertness.

CLEAN PUNCHING, clean machining, and good forming qualities permit Spaulding to work your exact specifications in fabricating even the most complicated shapes.

Consult your nearest Spaulding Branch Office for complete information.

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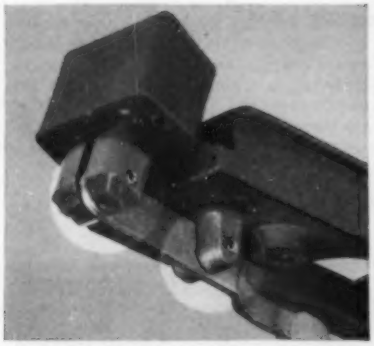
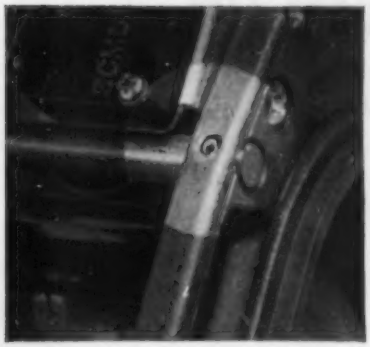
SPIROL PIN — a pivot, a stop, a fastener and a reinforcement in new DICTAPHONE® machine

While developing the impressive new Time-Master "5", Dictaphone engineers found the new SPIROL pin so versatile that it could be used as a pivot, as a stop, as a reinforcement, as a fastener! Here was a pin whose unique coil construction would eliminate drilling because it would lock securely to plastic in a pre-molded hole. A pin whose radial spring action would fasten firmly, yet could be easily removed and replaced in the field without damage to either fastening or hole. A pin that would eliminate reaming and riveting operations, and yet *was up to two-thirds lower in cost than fastenings that would do far less!*



SPIROL pins pivot plastic control button on microphone actuator and actuator arm on base casting in the hand microphone. Here SPIROL speeds assembly, eliminates a riveting operation. Used as a pivot in the new design microphone hook (not shown here) SPIROL's all-round tension enabled Dictaphone engineers to specify a *molded* hole in the plastic assembly, eliminating a drilling operation. The pivot inserts securely in the molded hole without machining.



SPIROL pin fastens the rear guide rod to the frame, where it not only holds firmly, but also provides for easy, quick removal and reinsertion in the field without damage to pin or hole. **SPIROL pin reinforces** as well as fastens the frame. Using a longer pin than normally required for fastening, Dictaphone engineers extended it deep into the body frame to give added strength. Here SPIROL replaced a dowel three times its cost, and saved a reaming job.

SPIROL 'stop' controls the movement of the cam, is easily inserted without reaming, absorbs shock better than solid pins. When compressed by insertion, SPIROL pins exert even radial pressure, develop no weak "hinge" lines. "Live" action keeps pins locked tightly in hole, makes them equally dependable in fastening fragile plastic or heavy metal parts. Standard sizes range from 1/32" to 1/2" diameters, 1/8" to 4" lengths. Special materials and sizes to order.

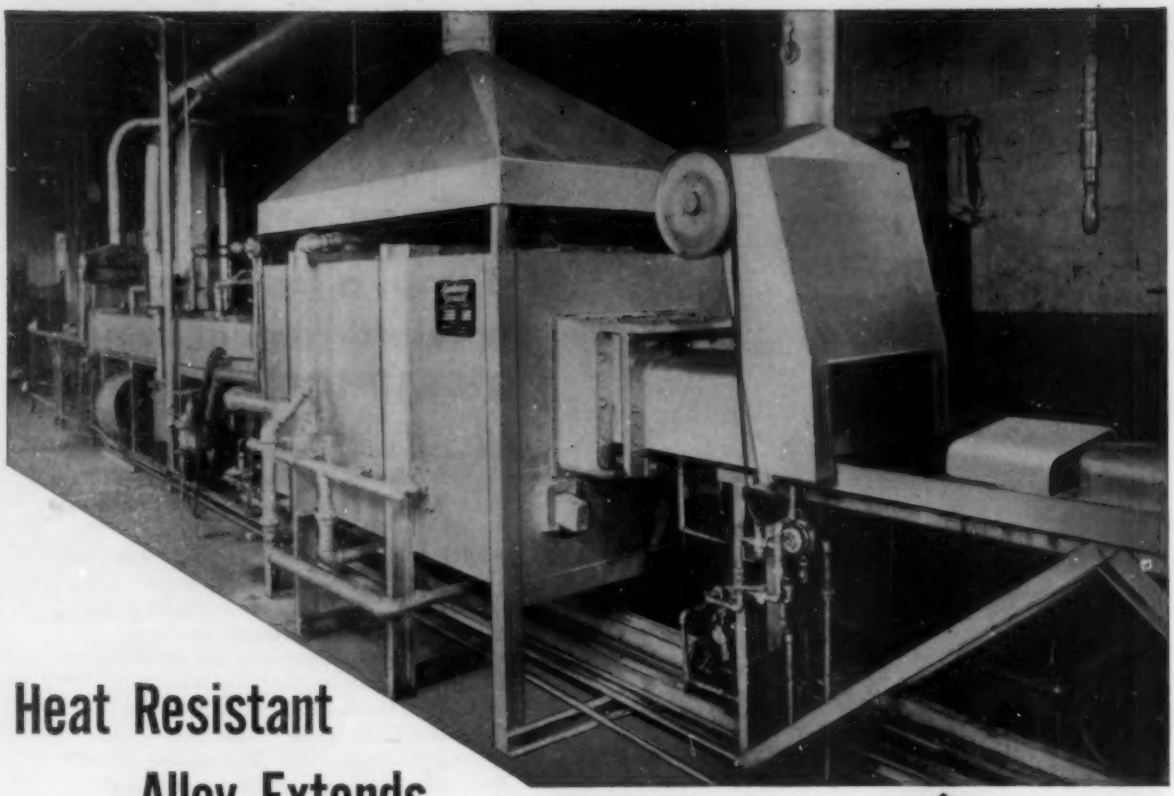
SPIROL's radial coils create even, all-round tension — resist shock and vibration

Write for illustrated folder and sample SPIROL pins.

SPIROL PIN

U. S. and Foreign Patents Pending

C. E. M. COMPANY • 62 SCHOOL STREET • DANIELSON, CONN.



Heat Resistant Alloy Extends Equipment Life

Still good after 14 years

The muffle of this annealing furnace has withstood continuous alternate heating and cooling since 1940, except for a shut-down period during the Korean war.

Still in use 14 years after installation, this casting... produced in 35% nickel-18% chromium heat resistant alloy ..demonstrates the economy of using nickel alloyed material to resist growth, warping, scaling and other deteriorating effects of heat.

From among the many engineering alloys containing nickel, you can select a material to provide the best set of properties for meeting one or a combination of requirements.

Let us help you find practical solutions to your metal problems. Make use of our counsel and data based on years of specialized experience in the fabrication, treatment, properties and performance of alloys containing nickel. Send us details of your problems for our suggestions.

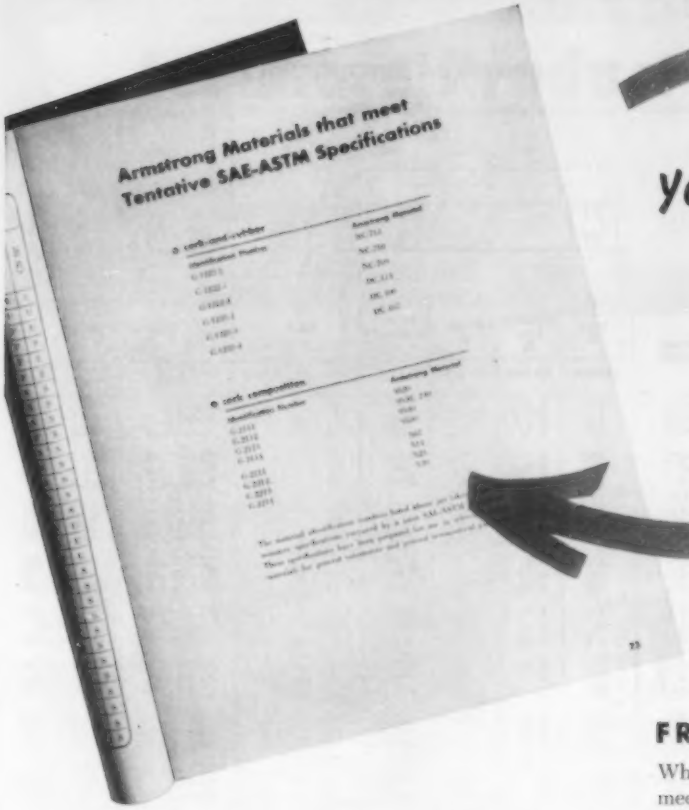
Original Muffle ...cast in a 35% nickel-18% chromium heat resistant alloy, trade-named "Chromax," and produced at the Harrison, N. J., plant of Driver-Harris Company . . . still serves after 14 years in this gas fired, controlled atmosphere, pusher-type furnace manufactured by Sunbeam Corporation, Industrial Furnace Division, Chicago 23, Ill.

Heat Resistant nickel-chromium alloy is also used for the annealing furnace conveyor.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

What Armstrong materials meet SAE-ASTM gasket specifications?



You'll find the answer in this newly revised gasket manual

17 helpful sections, including:

- **Designing flanges for efficient sealing**
- **Sealing with confined resilient gaskets**
- **Designing gaskets to reduce costs**
- **Effect of gasket width on compression**
- **Relation of gasket thickness to load**
- **Design problems peculiar to rubber gaskets**
- **Effect of surface conditions on gaskets**

FREE FOR YOUR FILES

When you want to know what gasket materials meet SAE-ASTM specifications, or have questions on gasket design, you can find helpful data in the 24-page booklet, "Armstrong's Gasket Materials." Newly revised for 1954, Armstrong's manual contains information vital to anyone concerned with gaskets or their design . . . includes details on the various types of gasket materials as well as important suggestions on gasket, flange and joint design. See it in Sweet's product design file. For your personal copy, send the coupon below.

ARMSTRONG'S GASKET MATERIALS

Armstrong Cork Co., Industrial Div.,
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Please send me your new 24-page gasket manual.

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Company _____

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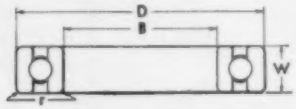
DIMENSIONS AND IDENTIFICATION



S

SS

Bearing Number	Bore B	Outside Dia. D	Width W	Fillet Radius* r	Balls		Bearing Numbers	
	Inches	Inches	Inches	Inches	No.	Size	Single Shield	Double Shield
XLS-1 3/16	1 3/16	2 9/16	9/16	0.047	11	5/16	XLS-1 3/16-S	XLS-1 3/16-SS
XLS-1 1/2	1 1/2	2 11/16	9/16	0.047	12	5/16	XLS-1 1/2-S	XLS-1 1/2-SS
XLS-1 5/8	1 5/8	2 7/8	9/16	0.047	12	11/32	XLS-1 5/8-S	XLS-1 5/8-SS
XLS-1 3/4	1 3/4	3	9/16	0.047	12	11/32	XLS-1 3/4-S	XLS-1 3/4-SS
XLS-1 7/8	1 7/8	3 9/16	5/8	0.047	12	3/8	XLS-1 7/8-S	XLS-1 7/8-SS
XLS-2	2	3 9/16	5/8	0.047	12	3/8	XLS-2-S	XLS-2-SS
XLS-2 1/16	2 1/16	3 7/16	5/8	0.047	14	5/16	XLS-2 1/16-S	XLS-2 1/16-SS
XLS-2 1/4	2 1/4	3 9/16	5/8	0.047	14	3/8	XLS-2 1/4-S	XLS-2 1/4-SS
XLS-2 3/8	2 3/8	3 3/4	11/16	0.047	14	11/32	XLS-2 3/8-S	XLS-2 3/8-SS
XLS-2 1/2	2 1/2	3 7/8	11/16	0.047	16	11/32	XLS-2 1/2-S	XLS-2 1/2-SS
XLS-2 5/8	2 5/8	4 1/8	11/16	0.047	16	3/8	XLS-2 5/8-S	XLS-2 5/8-SS
XLS-2 3/4	2 3/4	4 1/8	11/16	0.047	16	3/8	XLS-2 3/4-S	XLS-2 3/4-SS
XLS-2 7/8	2 7/8	4 1/2	3/4	0.047	16	3/8	XLS-2 7/8-S	XLS-2 7/8-SS
XLS-3	3	4 1/2	3/4	0.047	16	3/8	XLS-3-S	XLS-3-SS
XLS-3 1/8	3 1/8	4 3/4	3/4	0.047	17	3/8	XLS-3 1/8-S	XLS-3 1/8-SS
XLS-3 1/4	3 1/4	4 3/4	3/4	0.047	17	3/8	XLS-3 1/4-S	XLS-3 1/4-SS
XLS-3 1/2	3 1/2	5	3/4	0.047	19	11/32	XLS-3 1/2-S	XLS-3 1/2-SS
XLS-3 1/2	3 1/2	5	3/4	0.063	19	11/32	XLS-3 1/2-S	XLS-3 1/2-SS
XLS-3 5/8	3 5/8	5 1/8	3/4	0.063	19	3/8	XLS-3 5/8-S	XLS-3 5/8-SS
XLS-3 3/4	3 3/4	5 1/8	3/4	0.063	19	3/8	XLS-3 3/4-S	XLS-3 3/4-SS
XLS-3 7/8	3 7/8	5 3/8	7/8	0.094	18	7/16	XLS-3 7/8-S	XLS-3 7/8-SS
XLS-4	4	5 3/8	7/8	0.094	18	7/16	XLS-4-S	XLS-4-SS
XLS-4 1/8	4 1/8	6	7/8	0.094	19	7/16	XLS-4 1/8-S	XLS-4 1/8-SS
XLS-4 1/4	4 1/4	6	7/8	0.094	19	7/16	XLS-4 1/4-S	XLS-4 1/4-SS
XLS-4 3/8	4 3/8	6 1/4	7/8	0.094	20	7/16	XLS-4 3/8-S	XLS-4 3/8-SS
XLS-4 1/2	4 1/2	6 1/4	7/8	0.094	20	7/16	XLS-4 1/2-S	XLS-4 1/2-SS
XLS-4 5/8	4 5/8	6 1/2	7/8	0.094	21	7/16	XLS-4 5/8-S	XLS-4 5/8-SS
XLS-4 3/4	4 3/4	6 1/2	7/8	0.094	21	7/16	XLS-4 3/4-S	XLS-4 3/4-SS
XLS-4 7/8	4 7/8	7	1	0.094	20	1/2	XLS-4 7/8-S	XLS-4 7/8-SS
XLS-5	5	7	1	0.094	20	1/2	XLS-5-S	XLS-5-SS
XLS-5 1/8	5 1/8	7 1/4	1	0.094	20	1/2	XLS-5 1/8-S	XLS-5 1/8-SS
XLS-5 1/4	5 1/4	7 1/4	1	0.094	20	1/2	XLS-5 1/4-S	XLS-5 1/4-SS
XLS-5 3/8	5 3/8	7 1/2	1	0.094	22	1/2	XLS-5 3/8-S	XLS-5 3/8-SS
XLS-5 1/2	5 1/2	7 1/2	1	0.094	22	1/2	XLS-5 1/2-S	XLS-5 1/2-SS
XLS-5 5/8	5 5/8	7 3/4	1	0.094	22	1/2	XLS-5 5/8-S	XLS-5 5/8-SS
XLS-5 3/4	5 3/4	7 3/4	1	0.094	22	1/2	XLS-5 3/4-S	XLS-5 3/4-SS
XLS-5 7/8	5 7/8	8	1	0.094	23	1/2	XLS-5 7/8-S	XLS-5 7/8-SS
XLS-6	6	8	1	0.094	23	1/2	XLS-6-S	XLS-6-SS
XLS-6 1/4	6 1/4	8 1/2	1 1/8	0.094	22	9/16	XLS-6 1/4-S	XLS-6 1/4-SS
XLS-6 1/2	6 1/2	8 3/4	1 1/8	0.094	22	9/16	XLS-6 1/2-S	XLS-6 1/2-SS
XLS-6 3/4	6 3/4	9	1 1/8	0.094	23	9/16	XLS-6 3/4-S	XLS-6 3/4-SS
XLS-7	7	9 1/8	1 1/4	0.094	21	5/8	XLS-7-S	XLS-7-SS
XLS-7 1/4	7 1/4	9 3/4	1 1/4	0.094	22	5/8	XLS-7 1/4-S	XLS-7 1/4-SS
XLS-7 1/2	7 1/2	10	1 1/4	0.094	22	5/8	XLS-7 1/2-S	XLS-7 1/2-SS
XLS-7 3/4	7 3/4	10 1/8	1 3/8	0.094	21	11/16	XLS-7 3/4-S	XLS-7 3/4-SS
XLS-8	8	10 3/4	1 3/8	0.094	22	11/16	XLS-8-S	XLS-8-SS

* Bearing corner radii will clear maximum fillet radius shown.
Note:—These bearings are furnished with pressed steel retainers.

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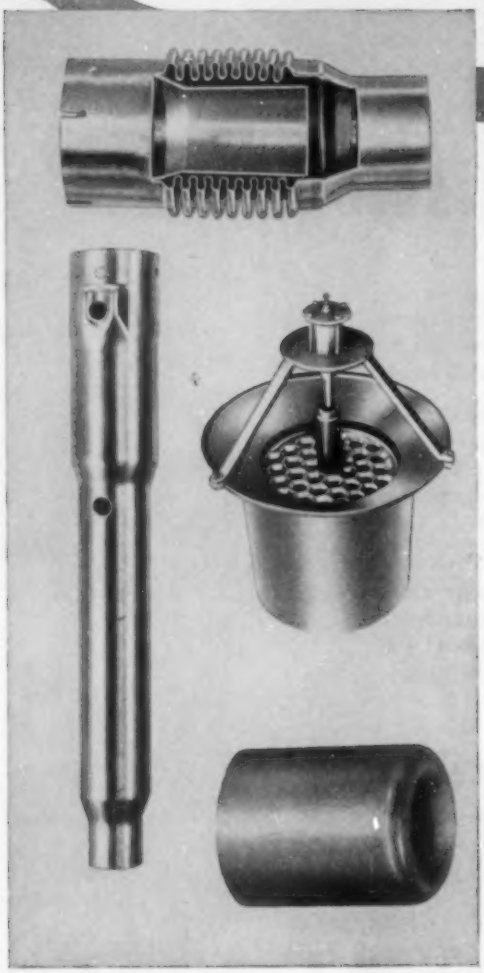
How to Design for More Product Efficiency



In the column at the left you'll see a few parts that may help you in your next design job. They demonstrate, somewhat, the possibilities of "design freedom" that come when you design with Carpenter Stainless Tubing in mind, because they show that modification of design to achieve economical working or fabrication is unnecessary when you specify "Carpenter".

In short, Carpenter stainless gives you those working properties that make for easy fabrication and low reject rate even when severe drawing, swaging, flanging or upsetting are required. In addition, Carpenter is delivered "as specified" in analysis, dimension, finish, tolerance and temper, piece after piece, order after order. It does not vary in quality.

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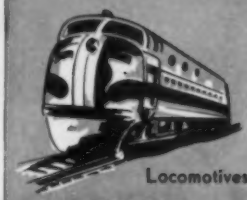

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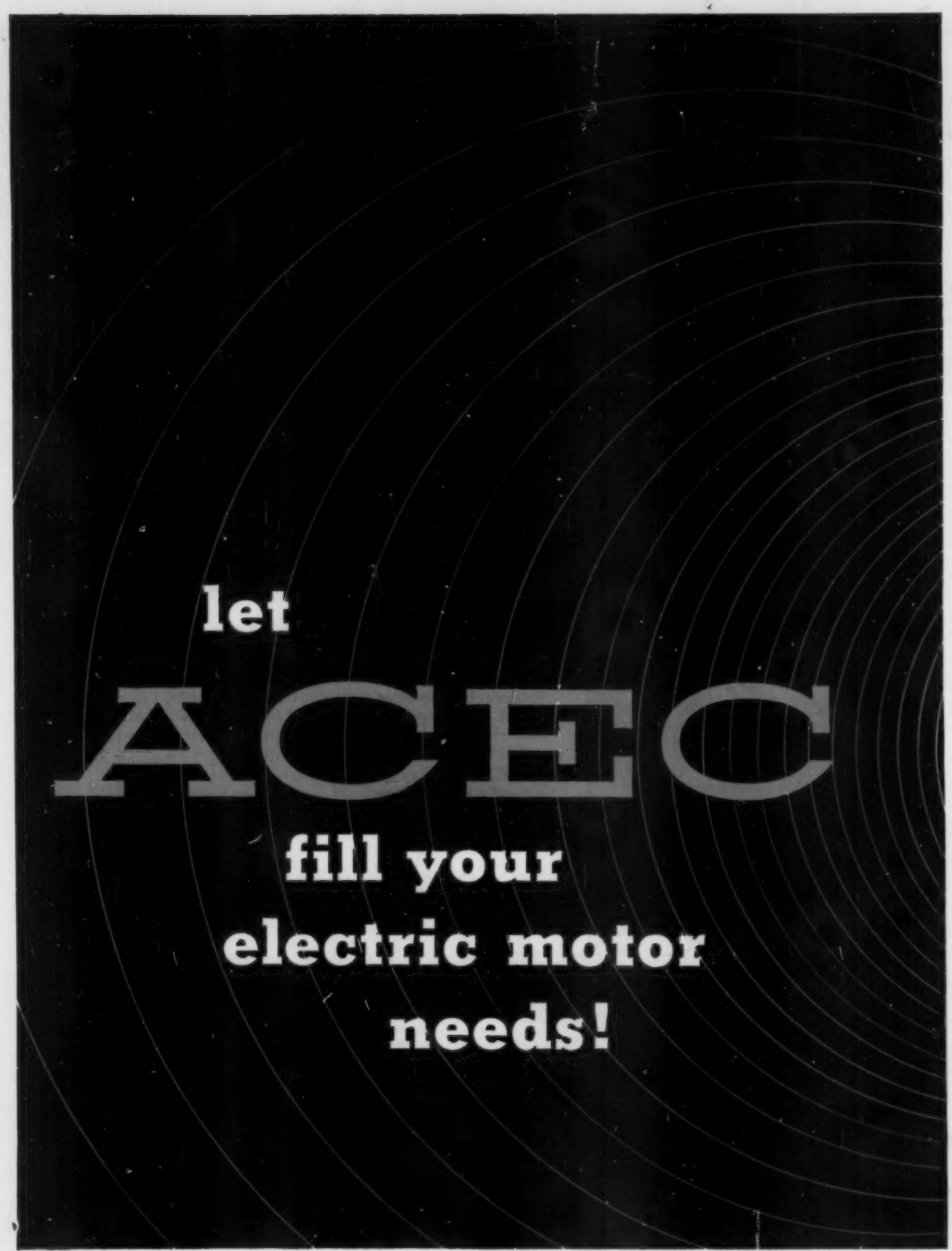

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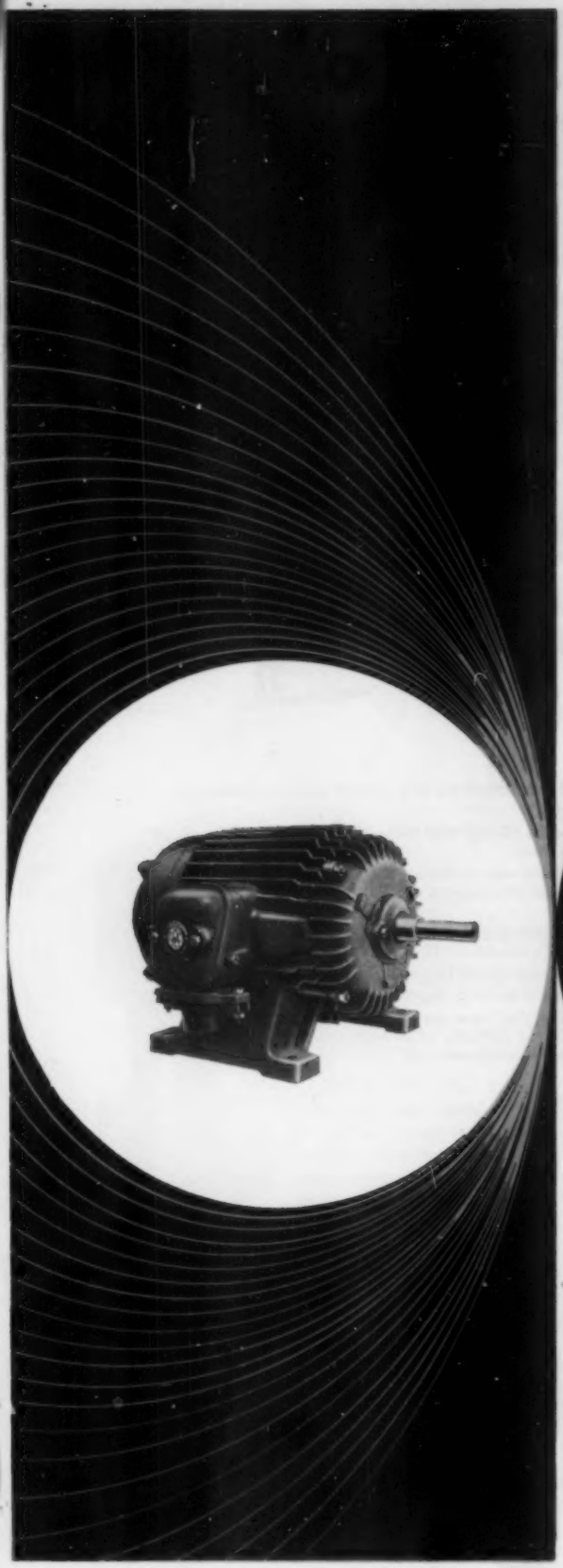

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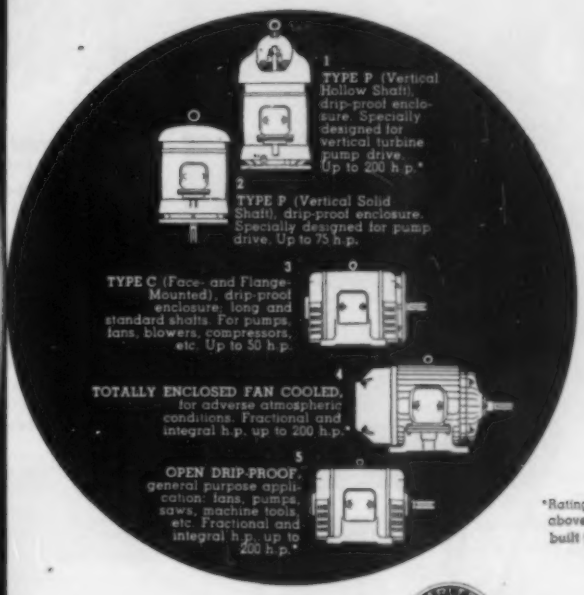
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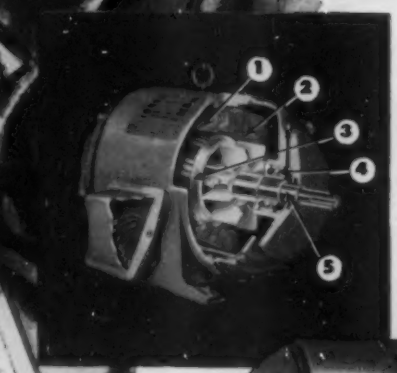

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Piston Pressure Switch bulletin describes in detail the entire service range from 15 to 3000 P.S.I. (7000 P.S.I. proof pressure). Belongs on Production Equipment, where millions of cycles are expected, and on Original Equipment, where flexibility and price are a factor.

Check number 9612 on the coupon below.

Solenoid Air Valves, the famous Crescent 3-way and 4-way valves, are catalogued with complete technical description in this eight-page brochure. Where long service without valve maintenance or solenoid trouble is essential, these valves have become standard.

Check number 3C-1 on the coupon below.

Barksdale Valves
5125 Alcoa Ave. L.A. 58, Calif.

BV-2 ☐ 3G ☐ 1B-2 ☐
M3 ☐ 9612 ☐ 3C-1 ☐

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

It has to be accurate ...it's welded tubing

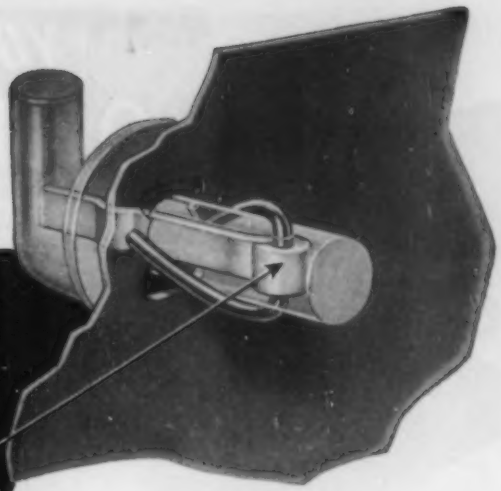
• Since welded tubing is formed from flat strip, the wall thickness must be uniform throughout. This advantage is so well recognized that tolerances for wall eccentricity are not commonly included in specifications.

Brainard welded steel tubing is an economical structural material, and it offers many such physical advantages. Can it cut costs or reduce weight in *your* product designs? For complete information write Brainard Steel Division, Dept. GG-2, Griswold Street, Warren, Ohio. An integrated producer; offices throughout the U. S.

Brainard
SHARONSTEEL
STEEL DIVISION
SHARON STEEL CORPORATION

WELDED STEEL TUBING

The ONLY plastic shelf support with the heart of steel



This steel insert, molded into plastic Spring-Locks, gives strength where it's needed—at the point of load or impact—eliminates doubts concerning the strength of plastic at these critical points. The metal insert increases the load-carrying capacity of the entire assembly.

The design flexibility of plastic Spring-Locks makes them ideal for a variety of applications. Shelf supports, washer cover knobs, drawer pulls and many other products made by such companies as Frigidaire, Philco, Easy Washing Machine and International Harvester have utilized the combination of utility, beauty and strength these versatile fasteners provide.

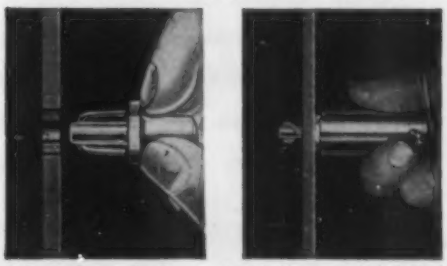
Spring-Locks cut material and assembly costs, too. No special tools, bolts, nuts or threadings required. Just a half-turn locks them securely, another quarter-turn and they're free.

Many standard shapes and sizes of Simmons Spring-Locks are available from stock—or any shape head can be designed for your individual needs. Whatever your fastening problem, we'll be glad to help you solve it. Why not send us the details, or call in a Simmons engineer today?

Any shape head can be molded for use as refrigerator shelf supports, lifter knobs, brackets, etc.

SIMMONS FASTENER CORPORATION
1751 NORTH BROADWAY, ALBANY 1, NEW YORK

HERE'S HOW SPRING-LOCKS WORK



1. Insert Spring-Lock *2. A half-turn and it's locked*
The steel insert carries the load.

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

Send for more data and Free Samples today.

YOU SAVE WHEN YOU USE OILITE FINISHED MACHINE PARTS

Sure... these intricate parts can be machined out of solid metal. *That's the expensive way.*

But... these **FINISHED MACHINE PARTS** are being made by **OILITE** *at a Fraction of the Cost.*

Oilite Finished Machine Parts serve the same purpose as conventional "machined" parts. Their performance is just as good, often better, because they can be self-lubricating and made to closer precision tolerances.

Recent achievements by Oilite Research have materially broadened the scope and application of Oilite Processing.

AMPLEX
DIVISION OF CHRYSLER CORPORATION
Detroit 31, Michigan, Dept. F

6543

Call an Oilite Engineer. Let him develop your ideas. He will suggest ways and means for decreasing your part costs and show you how to attain other important goals.

FIELD ENGINEERING, DEPOTS AND DEALERS THROUGHOUT UNITED STATES AND CANADA

Oilite Products Include:
BEARINGS, FINISHED MACHINE PARTS, CORED AND SOLID BARS, PERMANENT FILTERS AND SPECIAL UNITS

New
SKF Bulletin
Shows you how to get
Spherical Roller
Bearing capacity
Up 25% to 50%
life increased
2 to 3½ times...

Here, in a handy 12-page SKF Bulletin, is the information you need to take advantage of an SKF design improvement which

1. **Increases spherical roller bearing capacity 25% to 50%.**
2. **Increases service life 2 to 3½ times.**
3. **Carries heavier combined radial and thrust loads, or pure thrust loads of greater magnitude.**
4. **Is fully self-aligning.**

SKF *originated* the spherical roller bearing; now, again, the same pioneering kind of engineering provides industry with another important anti-friction first. This latest advance has been thoroughly proved over an extensive period in such applications as railroad journals, vibrating screens, steel mill machinery and other hard-service locations.

Send for your free copy of Bulletin No. 365-6 which gives complete facts—sizes available—increased life you can expect for each size. And remember that a Sales Engineer in any SKF District Office can and will help you make the best use of it.

7400

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—manufacturers of SKF and HESS-BRIGHT bearings.

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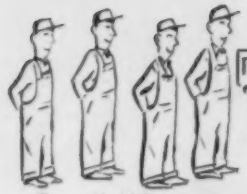
SKF®
BALL AND ROLLER BEARINGS

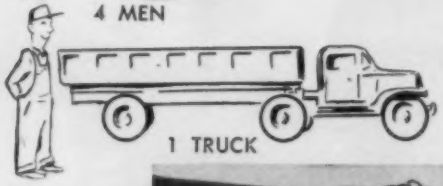
Before



4 MEN

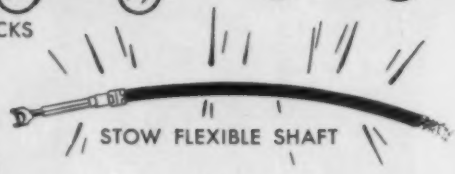
2 TRUCKS

After



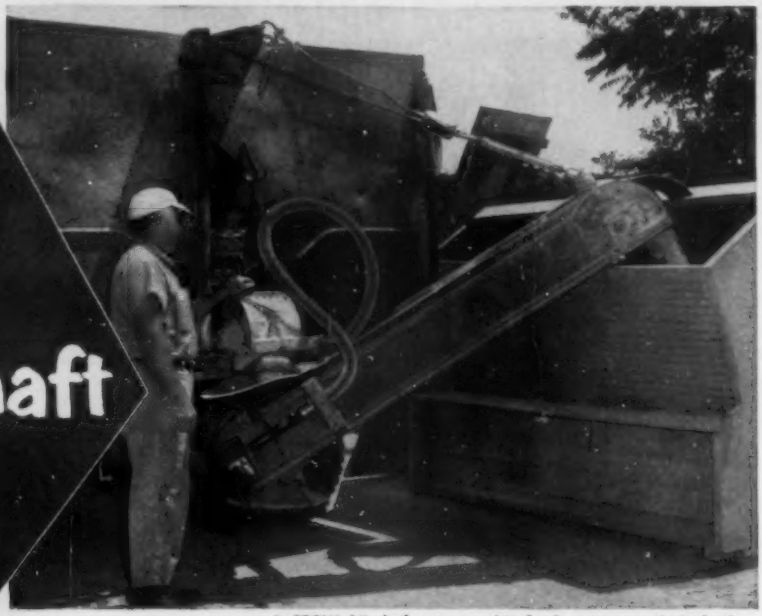
1 TRUCK

1 MAN



STOW FLEXIBLE SHAFT

A STOW flexible shaft makes the difference



A STOW 1" shaft powers this feed conveyor which feeds 200,000 ducks on a Long Island Duck Farm each day. Formerly 4 men, 2 trucks were required to do the job.

Again ingenuity and a STOW flexible shaft pay off!

Talk about efficiency...
One man, one truck and one STOW flexible shaft now do the job that formerly required 4 men and two trucks—*and in half the time!*

Yes, a STOW flexible shaft *makes the difference.* Perhaps you can use STOW flexible shafting to advantage in some of the power transmission problems you are working on right now. STOW engineers are at your disposal. Check on the advantages of flexible shafting in connection with your next power transmission problem.

Flexible shafting since 1875

Write today for FREE Engineering aids. This handy torque calculator and Bulletin 525 titled Engineering Data are yours for the asking. Write today on your company letterhead.

STOW

STOW MANUFACTURING COMPANY
426 State St. Binghamton, New York

New facts for your file on U·S·S HIGH STRENGTH STEELS

Truck body platform frames built of USS COR-TEN steel are 20% lighter...4 to 6 times more rust resistant

In truck mixer parts, USS MAN-TEN steel adds strength, increases resistance to abrasion, impact and vibration

In this 4½ cu. yd. Lite-weight, Heavy Duty Hi-Boy Truck Mixer built by Blaw-Knox Company, Pittsburgh, Pa., the mixing drum, mixing blades, charging hopper and discharge chute are made of USS MAN-TEN steel. In all these parts which are subjected to the highly abrasive action of the concrete batch, MAN-TEN steel's greater resistance to abrasion plays an important part in prolonging life and keeping maintenance costs and downtime to a minimum.

MAN-TEN steel's high endurance limit, 40% greater than carbon steel, and its high yield point of 50,000 psi are additional properties that pay off in increasing the durability of this equipment.

During the past 20 years, USS High Strength Steels—USS COR-TEN, USS MAN-TEN and USS TRI-TEN—have been used in materials-handling, road-building and excavating equipment of all kinds to reduce weight, increase working capacity and to give it the stamina to stay on the job.

Find out how these "steels that do more" can be applied to improve your equipment—how readily they can be fabricated—and how little they cost to use. A letter to our nearest district office will bring you this information.

By using 10-gage USS COR-TEN steel in place of 8-gage hot rolled carbon steel, Giant Manufacturing Co., Council Bluffs, Iowa, obtains maximum strength with minimum weight in the platform frames of their farm truck bodies.

This construction, which gives farmers and truckers several hundred pounds more loading capacity in these units—and thus cuts transportation cost per mile of load—has been used almost exclusively in Giant trucks since 1946.

"During this time," says the manufacturer, "we have not had a failure due to distortion or corrosion of the platform frames. Our fabrication department states that shearing and forming USS COR-TEN steel, using power equipment, is comparable to equal gages of regular carbon steel. COR-TEN steel's welding properties are excellent . . . it is easily prepared for application of enamel finish and has absolutely no tendency to flake or peel the finished coat."

Another well-known builder of farm wagons says, "We have found that the use of high strength steels is almost a must in the manufacture of farm equipment. All farm implements are subject to terrific abuse in the field and are generally without any protection whatsoever from the elements. The anti-corrosive qualities of high strength USS COR-TEN steel are naturally a major selling point in equipment of this type."

USS MAN-TEN steel saves weight, ensures longer life, in air-balanced oil pumping unit

Designers of equipment for the oil industry have found in USS High Strength Steels an economical and practical solution of many of their problems. How to reduce weight? How to increase strength? How to resist corrosion? How to prolong life?

Typical is this application of USS MAN-TEN steel in the walking beam of this ultra-modern air balanced pumping unit built by the Parkersburg Rig and Reel Company, Parkersburg, W. Va.

By using USS MAN-TEN steel construction in the 24 in. walking beam in place of carbon steel, the weight of this important member has been reduced 16.6%. Yet, because USS MAN-TEN steel has a yield point of 50,000 psi—one and a half times that of carbon steel—the lighter beam is much stronger. Additional durability is ensured by the fact that MAN-TEN steel has 40% higher fatigue strength, thus providing greater resistance to vibration and reversal of stresses.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on U·S·S CARILLOY STEELS

Improved suspension system of "Patton 48" features torsion bars of Carilloy steel

• In the army's newest medium tank, the Patton 48, torsion bars made from U·S·S Carilloy steel do a better job of cushioning riding shocks and take less mounting space than suspension systems used in World War II tanks.

In rugged field tests of the Patton 48, the torsion bars constantly flex, twist, and vibrate as the tank rumbles over trenches and scales 3-foot walls. U·S·S Carilloy 8660, a high quality electric furnace steel, performs exceptionally well in this torturous service.

U·S·S Carilloy steels are solving many tough jobs like this in both military and civilian applications. And it will pay you to look for a Carilloy steel when you need maximum strength, light weight, good corrosion resistance, or any combination of these properties in heavy-duty parts that must be small in size.

Cost cut 75% on wing flap supports with Rolled Structural T-sections of Carilloy steel

By switching from 2¼" x 3¼" alloy steel *bars* to hot-rolled T-sections of U·S·S Carilloy 4140 steel, J. C. Peacock Company and Consolidated Vultee Aircraft Corporation have reduced the cost and *improved the quality* of wing flap supports for Model 340 Convair airliners.

Flap tracks made of Carilloy T-sections not only are stronger than those formerly used, but require 4 hours less machining time and are machined with 60% less scrap loss. Finished tracks now cost only one-fourth as much as they used to.

As J. C. Peacock and Convair did, you will find exactly the alloy steel you need in U·S·S Carilloy. Carilloy steels are produced in the widest available range of analyses, sizes, forms, and heat treatments. They readily meet with the highest quality standards. If you need alloy steel of *any type* get in touch with our nearest District Sales Office.

U·S·S Carilloy steel produced in wide variety of plate, sheet, and strip

You can order flat-rolled *Carilloy steel* in anything from a razor blade strip to armor plate for a battleship. In U·S·S Carilloy, you get the widest selection of alloy steel plate, sheet, and strip that is obtainable from one producer. One source of supply makes purchasing easier, assures you consistent quality, and simplifies manufacturing problems.

Remember, too, when you buy Carilloy steels you have at your service, every day, the best metallurgical talent available. Our metallurgists have intimate knowledge of all types of alloy steels and their most economical fabrication. These men often can help you cut costs by offering practical suggestions on engineering and production.

For more information about Carilloy plate, sheet, and strip, and for free metallurgical assistance, get in touch with our nearest District Sales Office.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on

U·S·S STAINLESS STEEL

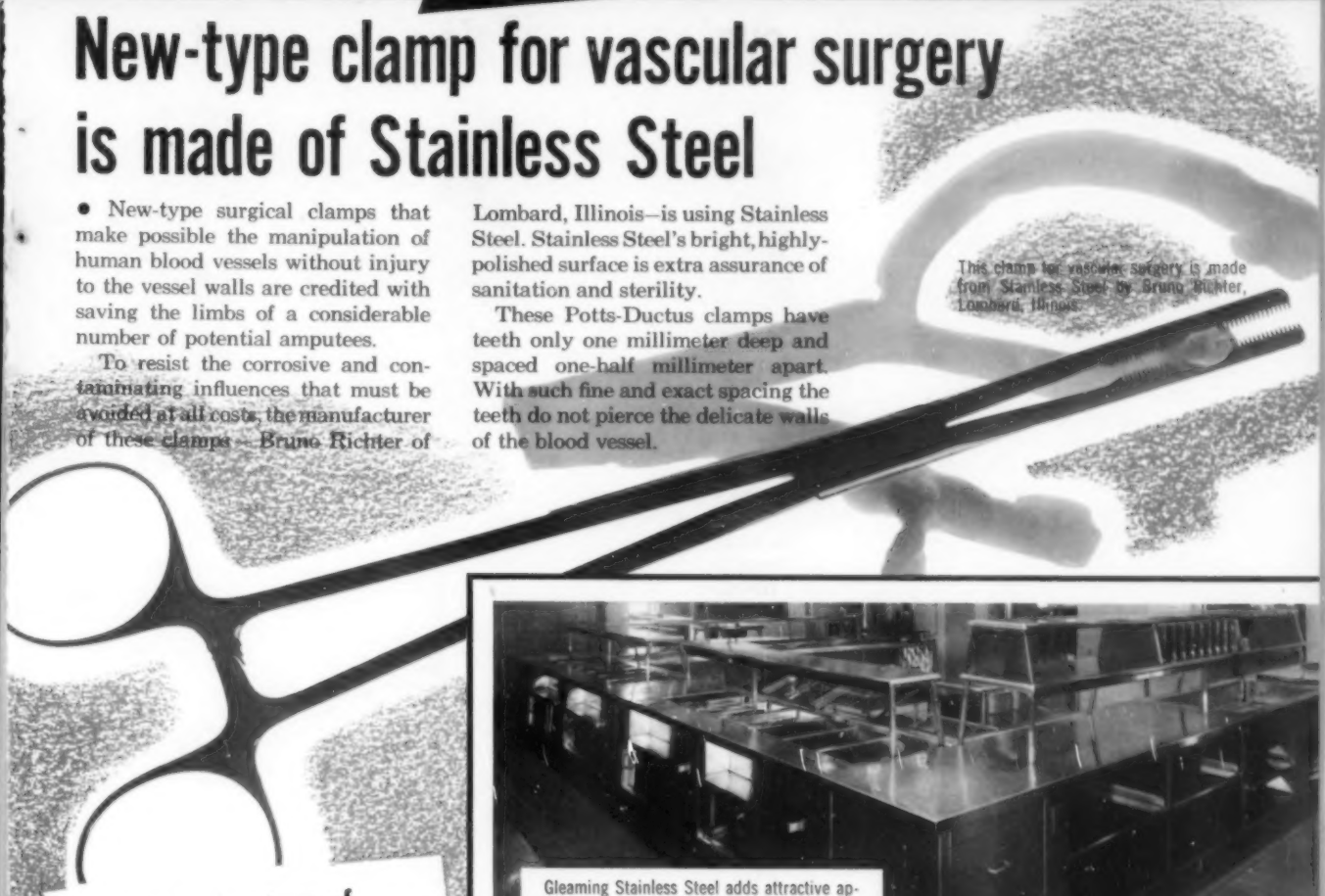
SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

New-type clamp for vascular surgery is made of Stainless Steel

• New-type surgical clamps that make possible the manipulation of human blood vessels without injury to the vessel walls are credited with saving the limbs of a considerable number of potential amputees.

To resist the corrosive and contaminating influences that must be avoided at all costs, the manufacturer of these clamps—Bruno Richter of Lombard, Illinois—is using Stainless Steel. Stainless Steel's bright, highly-polished surface is extra assurance of sanitation and sterility.

These Potts-Ductus clamps have teeth only one millimeter deep and spaced one-half millimeter apart. With such fine and exact spacing the teeth do not pierce the delicate walls of the blood vessel.



This clamp for vascular surgery is made from Stainless Steel by Bruno Richter, Lombard, Illinois.

Take advantage of Stainless Steel in your designs and in your selling

Here are more applications typical of the thousands in which Stainless Steel has been used to improve design and add sales appeal. The wide range of valuable properties available in Stainless Steel makes it the ideal material for many, many jobs.

Put Stainless to work for you. It will pay its own way and give you a good return on your investment—especially when it is perfected, service-tested U·S·S Stainless Steel.

Gleaming Stainless Steel adds attractive appearance and a host of other benefits to the employee cafeteria at H. J. Heinz Company, Pittsburgh. It was fabricated by Tyson Metal Products Company, Pittsburgh.

Stainless Steel's ease of cleaning makes it best for cafeteria use

Food handling is a "natural" for Stainless Steel. Stainless gives you an unmatched combination of sanitary qualities, ease of cleaning, a smooth, non-porous surface, resistance to corrosion and long life.

This cafeteria equipment was fabricated for H. J. Heinz Company, Pittsburgh, Pa., by Tyson Metal Products Company, Pittsburgh. It is made of a nickel-chromium grade of Stainless Steel.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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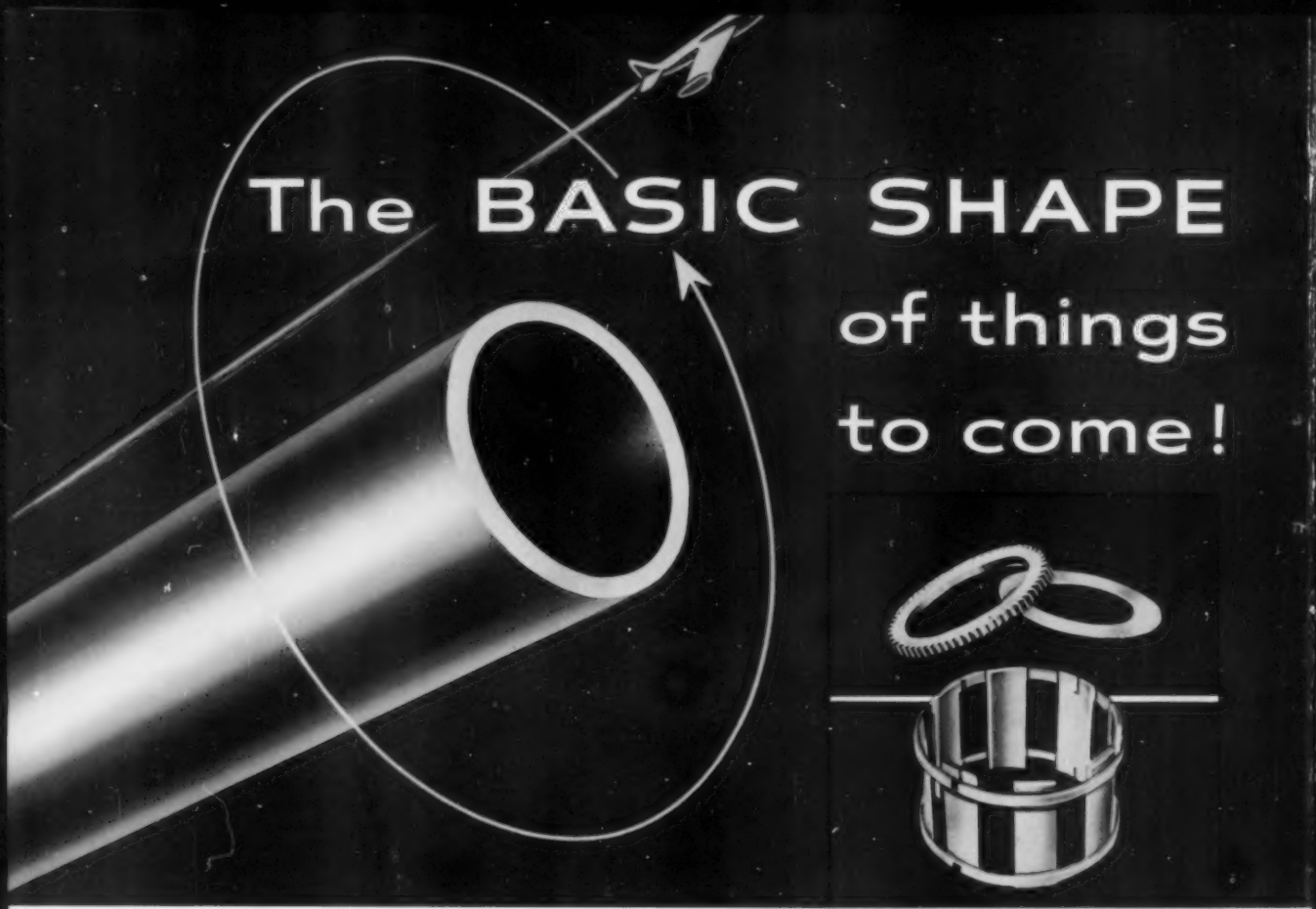
UNITED STATES STEEL



WHEN you use Shelby Seamless Mechanical Tubing for hollow cylindrical parts, the basic shape—the tube—is already made.

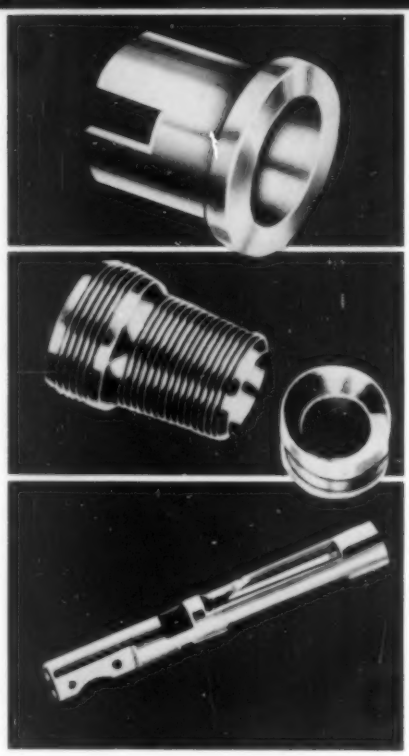
You pick up the job where Shelby leaves off, and you find that it requires much less cutting or boring than solid bar stock or forgings would.

You fashion the most complex of parts, yet you produce them faster and at lower cost than identical parts machined from solid bar stock.

You turn out a far better precision product, yet fewer operations are involved, man and machine hours are reduced, rejects are fewer, and over-all parts production is speeded up.

In some instances, the use of Shelby Seamless Tubing has increased production to such a degree that savings of 50 percent have resulted.

Shelby offers you the high strength, the uniformity, the dependability that only *seamless* tubing can give. And it's available in a complete range of diameters, wall thicknesses, and analyses to meet the most exacting requirements. If you're interested in cutting production costs—and who isn't?—while turning out a superior product, send for our free Bulletin Number 17. And feel perfectly free to call on our engineers if you need help in applying Shelby Seamless Steel Mechanical Tubing to your product.



NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
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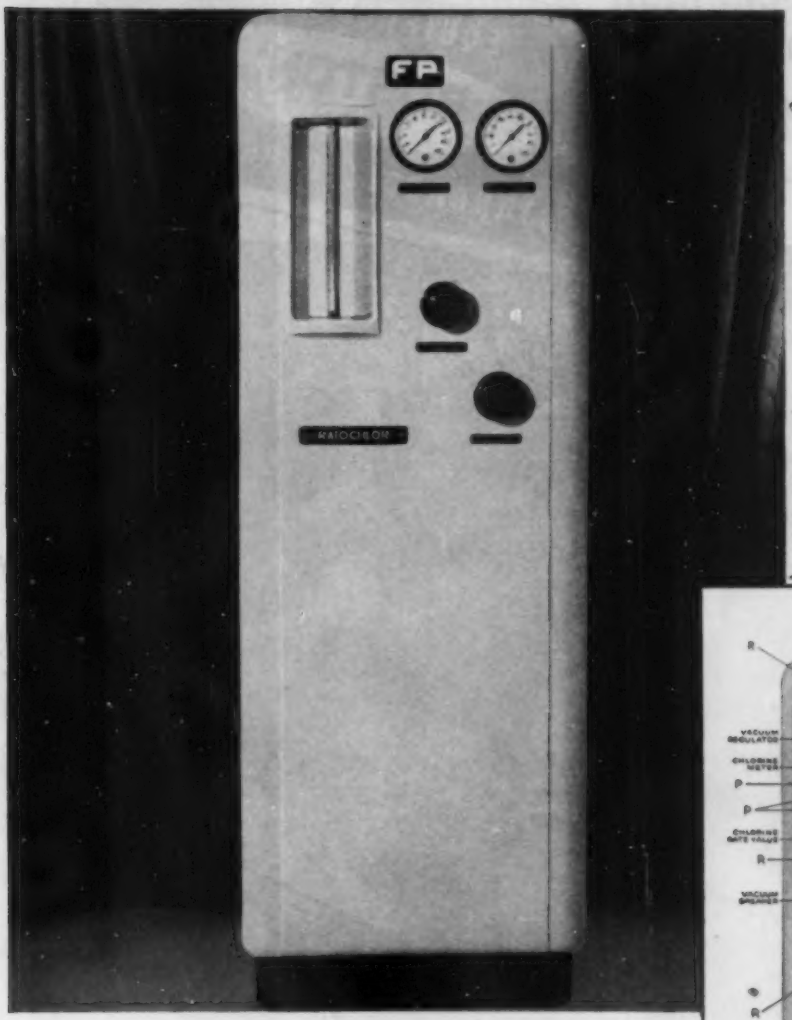
USS

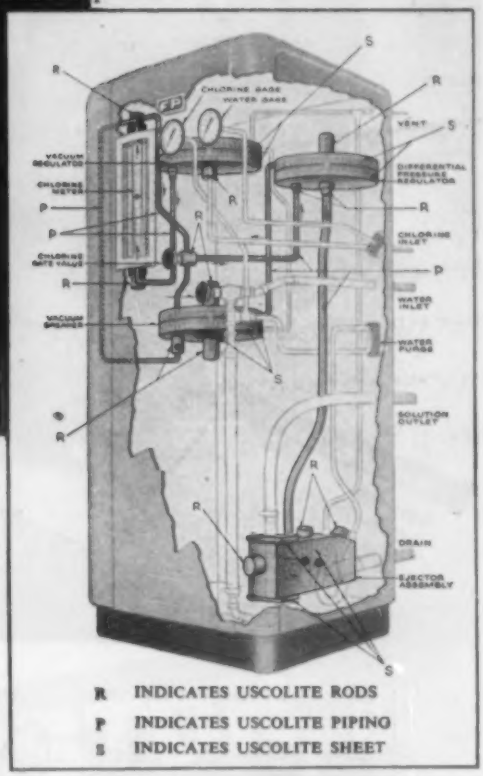
U·S·S SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

Unusual resistance to chlorine makes Uscolite® a "must" for this chlorinator



(Below) View of U.S. Uscolite Fittings in chlorinator. They are also used on machined flanges and connectors.



To handle chlorine, especially moist chlorine, requires the finest corrosion-resistant material, since this gas is more difficult to handle than hydrochloric acid. The manufacturer of this chlorinator, Fischer & Porter of Hatboro, Penna., in its search for the right material, selected U. S. Uscolite, after more than a year of testing *in their own* laboratories and in the field.

Uscolite is a thermoplastic made by United States Rubber Company. It is highly resistant to most chemicals, is extremely light, with great impact strength. Month by month, more and more manufacturers are finding that it gives them advantages unobtainable in any other material. Uscolite is an example of how "U. S." research scientists can invariably come up with a solution to a "they-said-it-couldn't-be-done" problem. Call any of our 25 District Sales Offices, or write to address below.

"U.S." Research perfects it
"U.S." Production builds it
U.S. Industry depends on it

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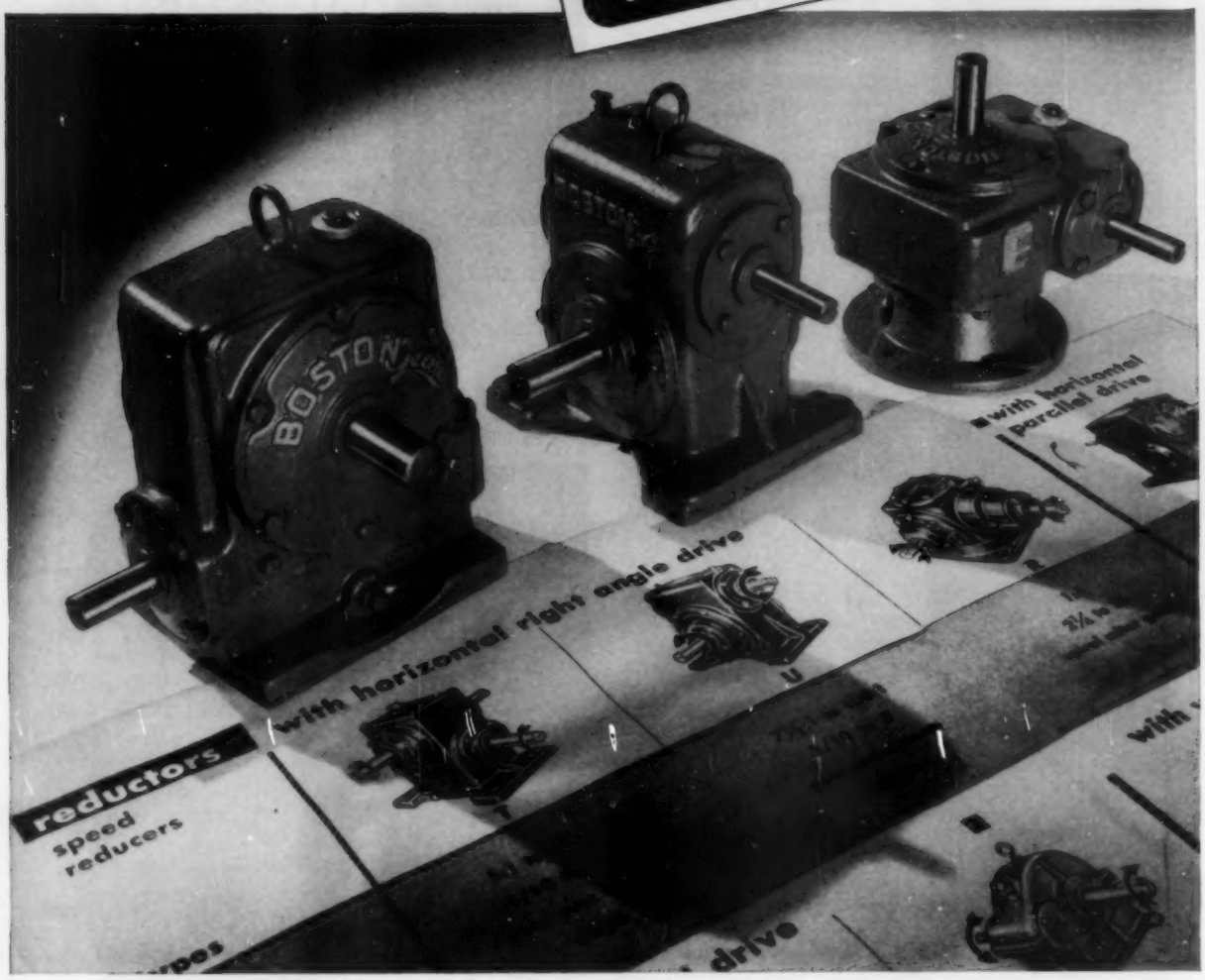
means approval by 250,000 cost-wise buyers

EQUIPPED WITH BOSTON Gear STANDARDIZED PRODUCTS



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SPROCKETS and CHAIN

SHOLD-A-GRIP Interchangeable Tapered BUSHINGS and SPROCKETS

RATIOMOTORS

REDUCTORS

A $10,000,000 STOCK • AT 92 LOCAL DISTRIBUTORS

SHAFT SUPPORTS

UNIVERSAL JOINTS

COUPLINGS

Design around the Speed Reducers that add service life . . . and extra sales

It's good sales sense to specify BOSTON Gear REDUCTORS or RATIO-MOTORS when your product's design calls for speed conversion.

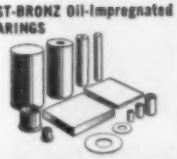
BOSTON Gear is a name your prospects know and trust. It's also your lowest cost *insurance* of customer satisfaction . . . and repeat orders. Here's why:

1. **LEADING SPECIALISTS** in standardized machine drive parts for 75 years.
2. **LARGEST PRODUCTION** facilities, serving 250,000 customers in all industries.
3. **HIGHEST QUALITY.** Assures immediate interchangeability, anytime, anywhere.
4. **LOWER COST.** Longest service life assured by BOSTON Gear quality.
5. **WIDER RANGE** of standard types and sizes. REDUCTORS. 005 hp to 36 hp — RATIOMOTORS 32 types, 1/20 hp to 3 hp
6. **NEARBY STOCKS** at leading supply centers . . . the nation-wide network of 92 BOSTON Gear Distributors . . . with stocks totaling $10,000,000.

These are more than advantages . . . they are *essentials* to trouble-free planning and servicing of any product assembled with standardized stock parts. Only BOSTON Gear offers them *all*. Compare — and you'll agree — it pays to "Design around BOSTON Gear."

For advice on speed conversion problems, talk with a specialist, the BOSTON Gear Field Engineer. Ask your BOSTON Gear Distributor to arrange a call, or write: Boston Gear Works, 71 Hayward Street, Quincy 71, Mass.

BOST-BRONZ Oil-Impregnated BEARINGS



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Industry's most valued "textbook" of drive design and maintenance . . . includes 30 pages of Engineering data.

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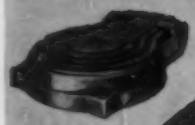
FOR PROMPT DELIVERIES AT FACTORY PRICES

BALL BEARINGS

Look under "Gears" in the Yellow Classified Section of your Telephone Directory for the BOSTON Gear Distributor nearest you.

SPECIALISTS IN METAL STAMPINGS

FOR OVER 70 YEARS

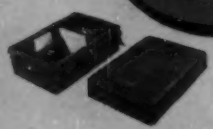


Base For Power Lawn Mower

G.P.&F.®

Solenoid Cover U.S. Navy

Aerial Delivery Container U.S. Air Force



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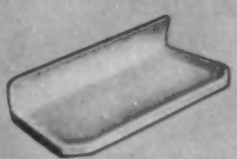
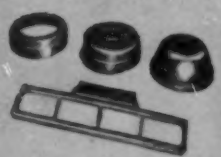
Over 1000 skilled people ... 289 deep draw and stamping presses ... 92 welding machines ... 15 acres of production facilities ... complete tool and die department.

Washing Machine Tub



Scale Platter

Safety Guard for Power Tools



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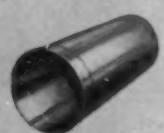
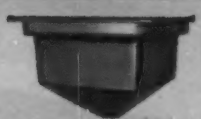
TINNING • GALVANIZING • WELDING
LEAD COATING • SPRAY FINISHING
VITREOUS ENAMELING



Longhorn Cheese Mold

Commercial Fruit Juicer

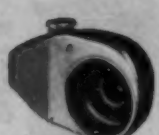


Deep Fat Fryer Pot

Transmitter Case

Cover for Ice Cream Freezing Equipment

Christmas Tree Stand



Fuel Tank

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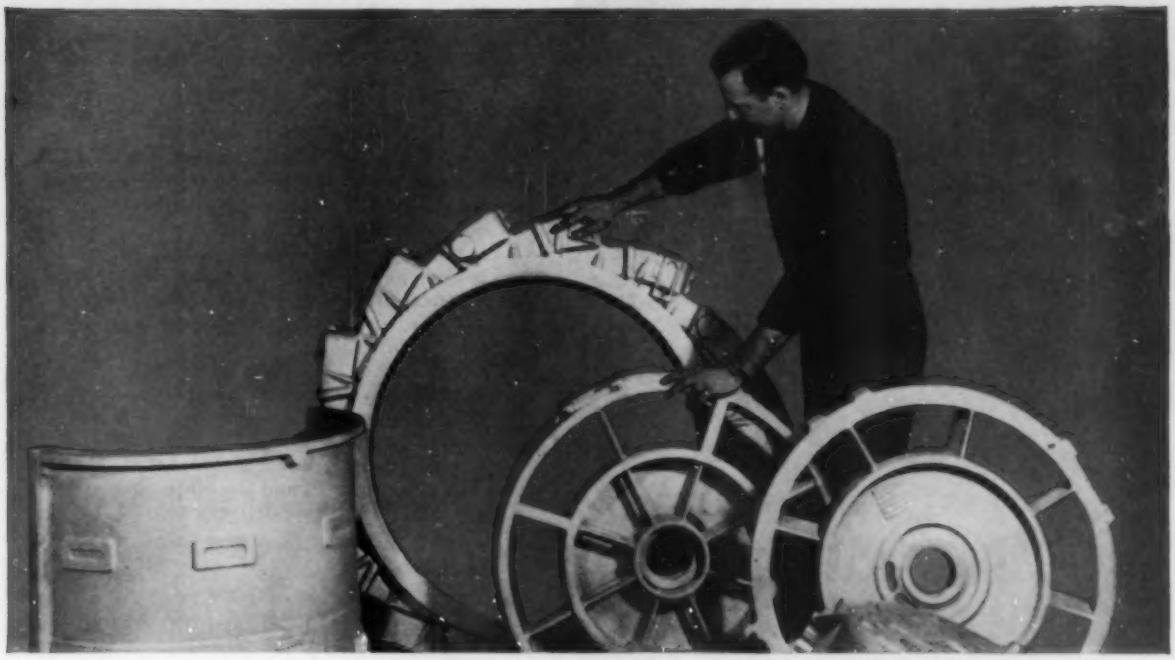
DOW

LIGHTER, MORE RIGID CASTINGS MADE WITH DOW MAGNESIUM

Production economies also offered by sand and permanent mold castings



Lighter, yet more rigid castings! That's the big advantage of magnesium in sand and permanent mold castings.

By increasing section thickness and adding stiffening ribs, greater rigidity is possible. And because of magnesium's high strength to weight ratio, total weight can be cut.

Magnesium also offers outstanding production advantages. Chief among these is magnesium's excellent machinability. There are many instances where time saved in machining has lowered the cost of the finished part beyond that of any other metal. Cutting tools last longer; replacement costs and downtime for sharpening and resetting are reduced.

Look, too, at the cost saving possible in handling. Magnesium's lightness can cut the costs of shipping, from raw casting to finished product. In-plant materials handling costs can also be reduced appreciably when lighter castings are used.

For further information on the advantages of magnesium, contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, *Magnesium Department*, Midland, Michigan.

you can depend on DOW MAGNESIUM

DOW

Consistent Performance

is "engineered" into

Waterbury Phosphor Bronze & Nickel Silver

You can expect uniformly successful results from every coil of Waterbury Rolling Mills Phosphor Bronze and Nickel Silver. Here is the reason why.

WATERBURY'S QUALITY CONTROL keeps a close watch on the metal from composition, through processing to shipment. Raw materials are carefully selected, combined and processed under the constant scrutiny of Waterbury's metallurgical laboratory. This assures a consistency of grain size and structure plus physical and electrical properties that give you uninterrupted success in your application.

Remember also, that Waterbury's metallurgical experience is available to help you on specific problems.

Specify Waterbury Rolling Mills phosphor bronze and nickel silver. You can order it from the office nearest you. You'll get fast delivery too.

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WR-8

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If you are interested in design, development and production of new and unique products or components, this 20-page booklet of I-T-E's Special Products Division will help you.

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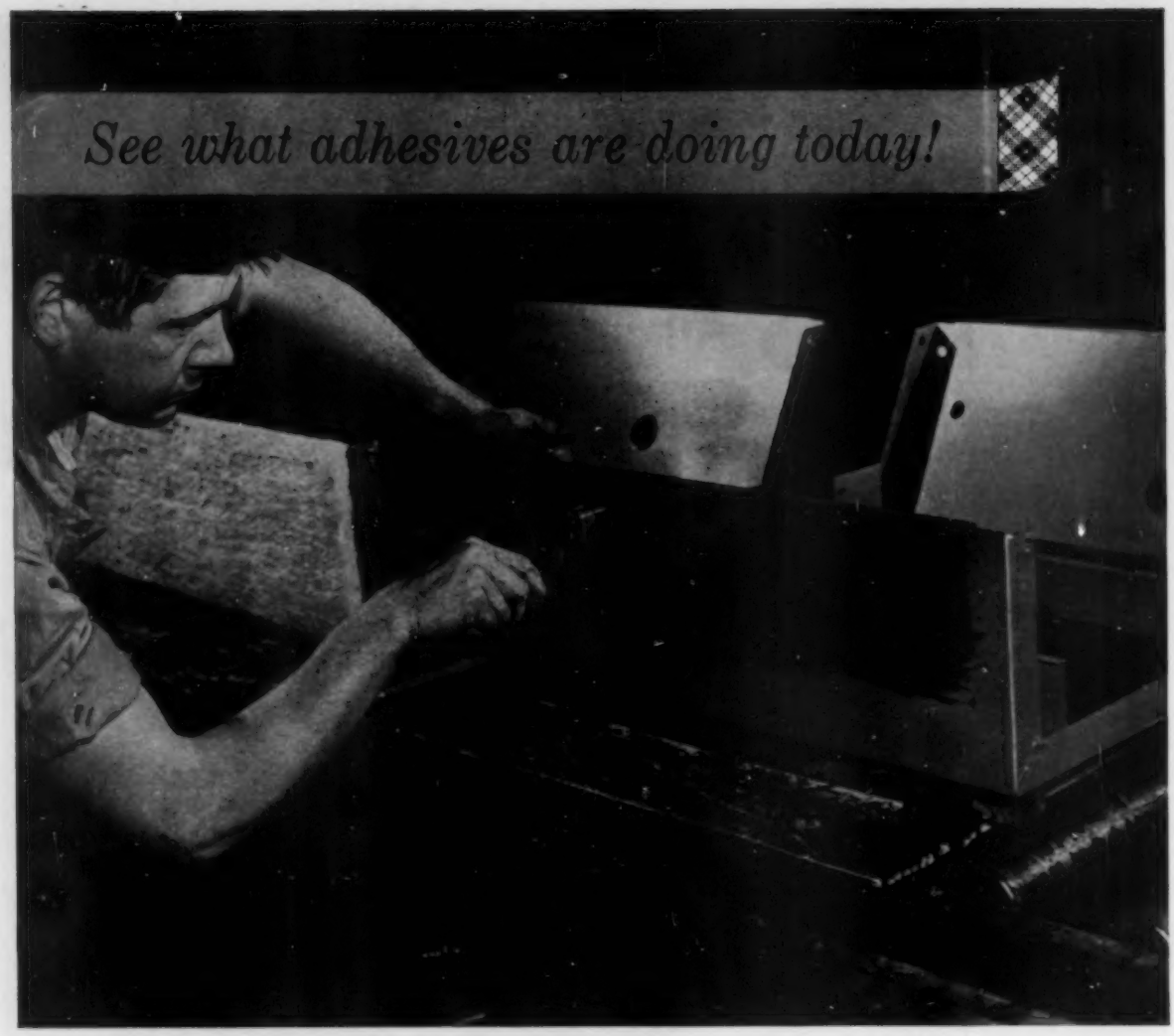

Keeping Carrier's coolers quiet

A room air conditioner is a mighty fine aid to comfortable summertime sleeping, provided it does its job quietly. Thus, most of the big manufacturers like the Carrier Corporation at Syracuse, New York, use fibrous glass insulation to muffle any noise or vibration which might interfere with sound slumbers.

Carrier uses 3M's EC-104 adhesive to quickly and firmly attach this filmy insulating material to motor housings and other curved metal surfaces within their unit. A quick brush coat of adhesive . . . press the fibrous glass pad in place, and the assembly moves down the production line without a hitch.

See what adhesives can do for you . . . Next time you're faced with the problem of bonding together dissimilar materials, consider the advantages 3M Adhesives offer. Send for our latest Designer's Handbook which shows how better designs and lowered unit costs can be achieved with the aid of these modern bonding materials. Address your request to 3M, Dept. 42, 417 Piquette Ave., Detroit 2, Mich.

3M COMPANY

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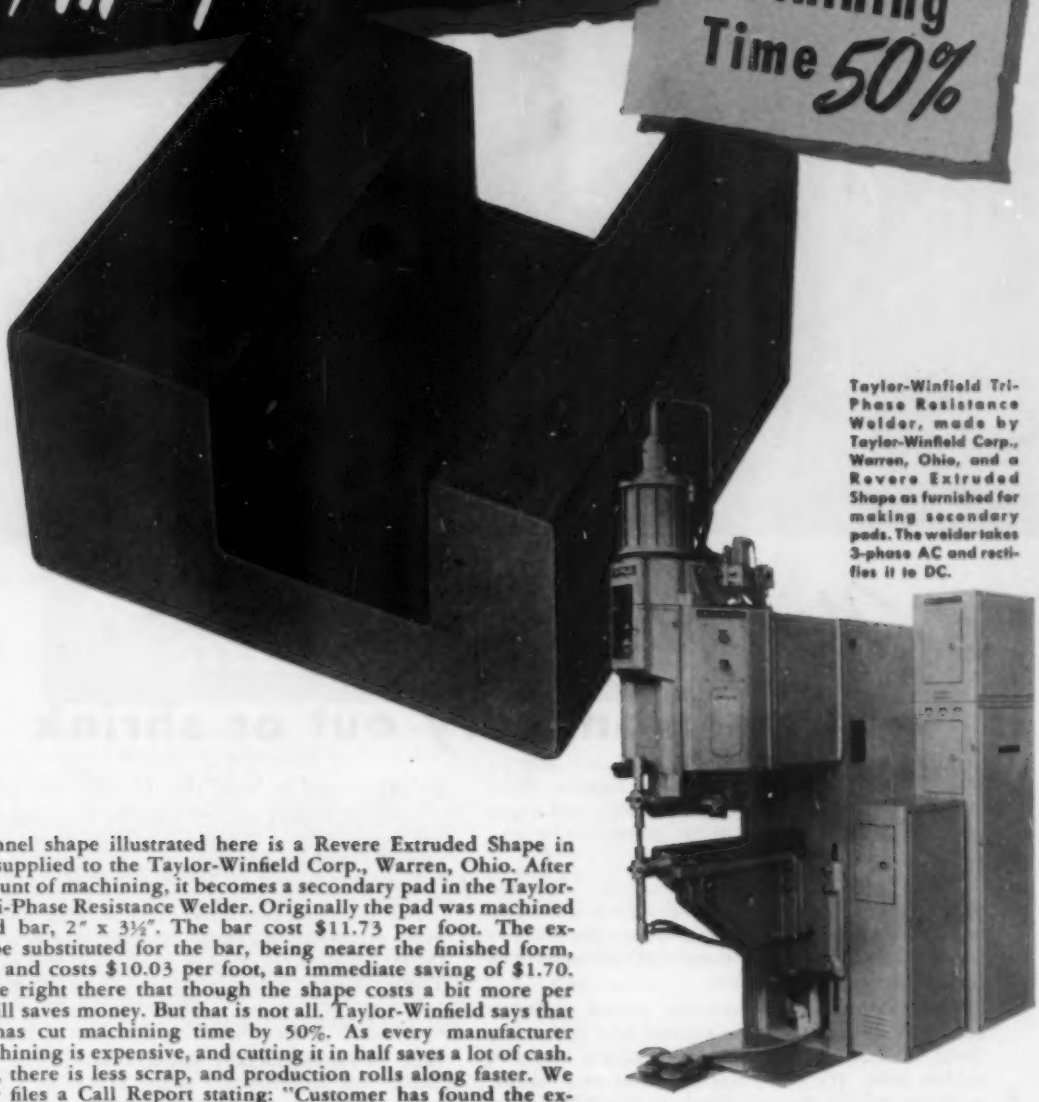
REVERE

Extruded Shape SAVES $1.70 per foot...

CUTS Machining Time 50%



Taylor-Winfield Tri-Phase Resistance Welder, made by Taylor-Winfield Corp., Warren, Ohio, and a Revere Extruded Shape as furnished for making secondary pads. The welder takes 3-phase AC and rectifies it to DC.

● The channel shape illustrated here is a Revere Extruded Shape in copper, as supplied to the Taylor-Winfield Corp., Warren, Ohio. After a small amount of machining, it becomes a secondary pad in the Taylor-Winfield Tri-Phase Resistance Welder. Originally the pad was machined out of solid bar, 2″ x 3½″. The bar cost $11.73 per foot. The extruded shape substituted for the bar, being nearer the finished form, weighs less and costs $10.03 per foot, an immediate saving of $1.70. You can see right there that though the shape costs a bit more per pound, it still saves money. But that is not all. Taylor-Winfield says that the shape has cut machining time by 50%. As every manufacturer knows, machining is expensive, and cutting it in half saves a lot of cash. In addition, there is less scrap, and production rolls along faster. We have in our files a Call Report stating: "Customer has found the extruded section very satisfactory, and bases his machining time-saving on production runs and not estimates."

Credit for this fine achievement has to be shared by a number of people, both in Taylor-Winfield and in Revere. Our Sales and Technical Advisory staffs collaborated closely with the customer's engineering, production and purchasing personnel. Everybody considered all angles, and worked out this money-saving plan.

So we suggest that if you are doing any extensive machining of copper and copper alloys, or aluminum alloys, it would be a good idea to look into Revere Extruded Shapes. They might offer you important economies. We will be glad to consult with you. Just get in touch with the nearest Revere Sales Office.

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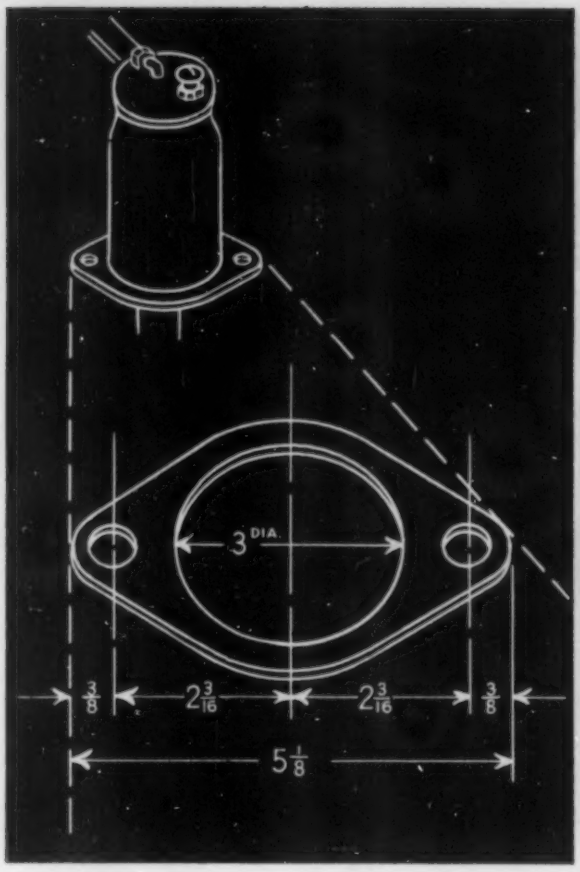

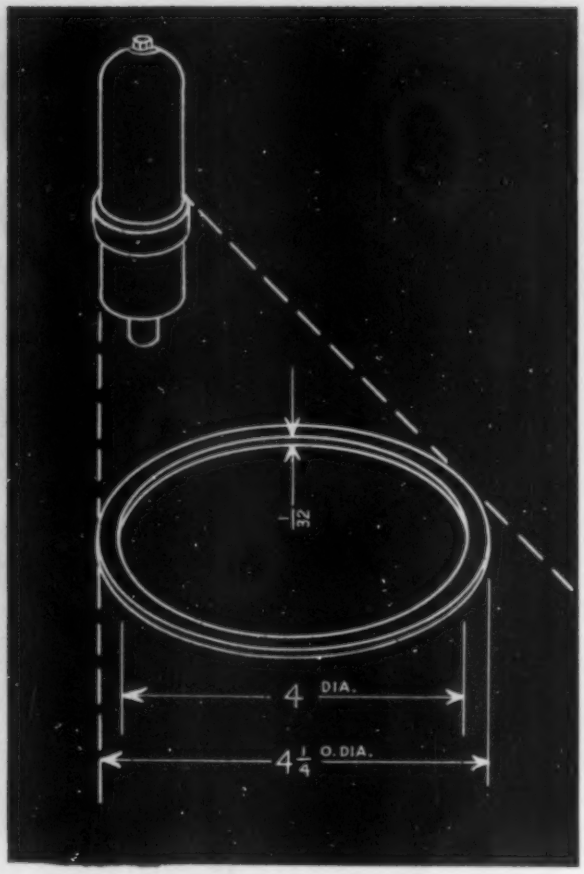

New fiber gasket

won't dry out or shrink

Glue-glycerine saturants normally are fugitive. When they leave a plant fiber gasket material, a gasket gets dry, shrinks, and usually leaks. In storage, it may distort and become unusable.

That's what a tractor manufacturer discovered when the fiber gasket in the engine governor shown at left above brought complaints from the tractor's users. Oil had leached out the gasket's glue-glycerine binder, causing gasket failure.

After testing several materials, tractor engineers solved the problem with an entirely new gasket material—Armstrong's Accopac®. Accopac's binder is rubber latex. It's non-extractable and non-volatile, so Accopac can't dry out, shrink, or crack in service. Field tests on Accopac CS-301 showed it positively prevented oil leaks at the governor flange. So, when Accopac went into production, complaints stopped.

Accopac helped this manufacturer solve a production problem, too. The oil filter ring shown at right had to be stored for several months. Many of these gaskets warped so badly they became unfit for use.

Accopac gaskets are now used for this sealing job, too, because their dimensions and performance are virtually unaffected by variations in temperature and humidity. They still fit even after months of storage.

Accopac's excellent dimensional stability and high, even compressibility have brought this new fiber material wide acceptance in a variety of sealing jobs. Today, Accopac is used in thousands of applications—in pumps, aircraft, automatic washers—wherever there's a need for efficient sealing at low cost.

FREE 24-PAGE GASKET MANUAL—For full information on Accopac and other Armstrong's gasket materials, see the 1954 edition of "Armstrong's Gasket Materials." It has 24 pages of specification information, data on cost reduction, gasket tolerances, etc. See it in Sweet's product design file. For a personal copy, write Armstrong Cork Company, Industrial Division, 7002 Irvin Street, Lancaster, Pennsylvania.

ARMSTRONG'S ACCOPAC

The answer to most of your questions about stainless steels are right at your finger tips, when you use Crucible's unique new Stainless Steel Selector.

Want to know the machinability characteristics of a stainless grade? Resistance to corrosion or scaling? Physical or mechanical properties? You can get the answers to these and other questions simply by setting the arrow on the Selector slide at the proper window. It's just as quick and easy as that.

And almost as fast as you get the answer, you can get the steel you need. For many of the REZISTAL stainless steels shown on the Selector are carried in stock in Crucible warehouses conveniently located throughout the country.

To get your free copy just fill in and mail the coupon. Better do it now.

HOW THE SELECTOR WORKS:

Start with the problem. For example, resistance to corrosion in contact with copper sulfate. Just set the slide at the proper index number shown on the Selector (in this case on the back), and you have the answer in a second – grades 302 and 316 are fully resistant to this form of attack.

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CRUCIBLE first name in special purpose steels

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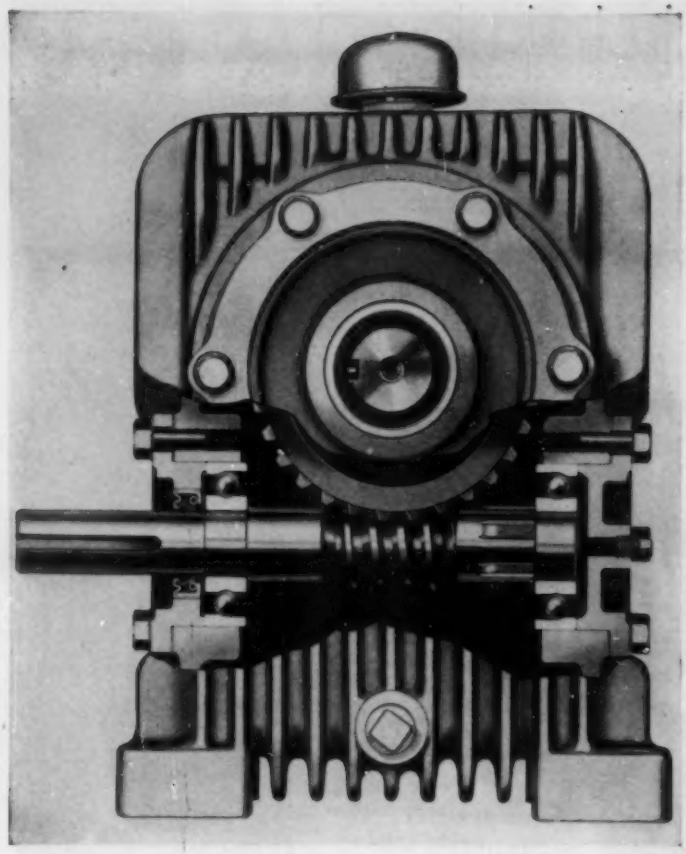
CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • MAX-EL • ALLOY • SPECIAL PURPOSE STEELS



• MORE HP PER POUND
• MORE HP PER CUBIC INCH
• MORE HP PER DOLLAR

TAKE A LOOK AT EFFICIENCY

. . . it belongs in every driven product

You're looking at the "innards" of the most efficient worm geared speed reducer available today. It's Cone-Drive Gear's exclusive double-enveloping worm gear design, which means more load-carrying capacity, size for size, than any other type of right-angle speed reducer.

This simple design, with the gear and worm literally "wrapped" around each other, means a space and weight savings that often makes the difference between a compact, efficient product and just another machine.

You can specify (from stock) any one of 190,000 standard models of Cone-Drive gears to handle loads from fractional to 800 hp. You can have ratios from 5:1 to 4900:1. Fan-cooled or water-cooled models available if you should need them.

Interested? Get complete details in Bulletin 8901-50.

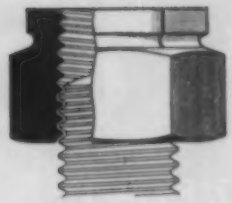
CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

Manufacturers of couplings like these find that FLEXLOC Self-Locking Nuts provide faster assembly and safer, more dependable locking than is afforded by most other methods.

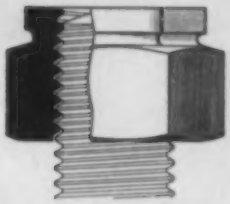
Here's why more and more original equipment manufacturers specify FLEXLOCs

Whether it's on power transmission couplings or on access doors of helicopters, more and more FLEXLOC Self-Locking Nuts are being used to insure positive fastening of assemblies.

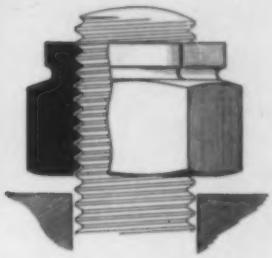
There are many reasons for this. FLEXLOCs reduce production costs. They are easy to install. They are one piece, all metal—nothing to assemble, come apart, lose or forget. They eliminate complicated, time-consuming methods of locking bolts and studs. They stay put—once their locking threads are fully engaged, they won't work loose. They are easy to get—SPS can make prompt delivery of FLEXLOCs in any quantity, and in a wide range of sizes, through a national organization of industrial distributors. Write for literature and samples. STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.



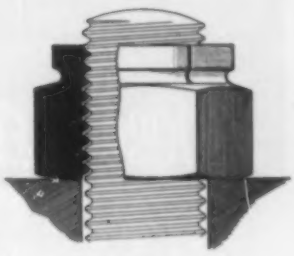
Starting. A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



Beginning to Lock. As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



Fully Locked As a Stop Nut. When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.



Fully Locked As a Seated Nut. When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

FLEXLOC® LOCKNUT DIVISION

SPS
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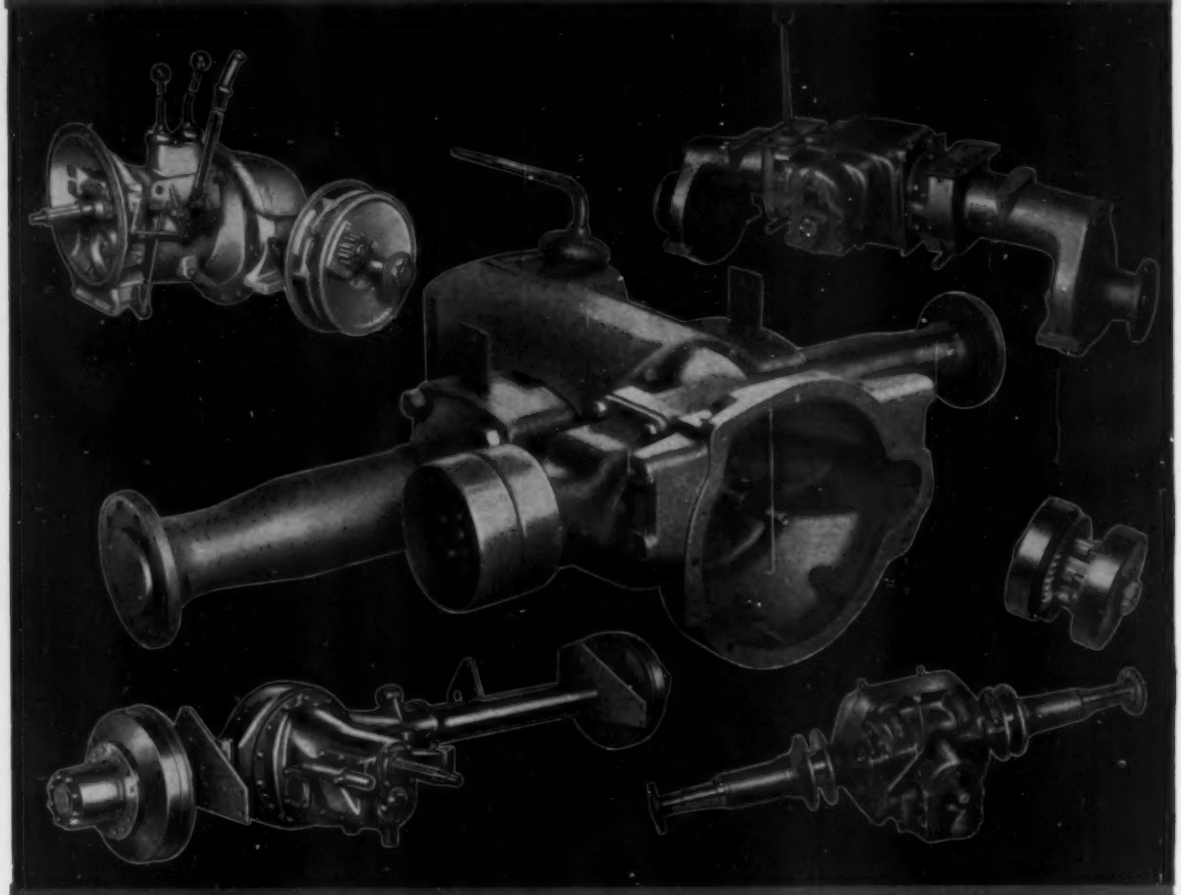
"CLASS"

THAT RESULTS IN DEPENDABILITY



—these CLARK axle-transmission Drive Units

There is no established pattern, no single design of Clark Drive Units for heavy duty equipment—agricultural, industrial or highway—because each one is special: created for a specific vehicle, built to do a particular job. It makes good sense: your engineers and Clark engineers drawing upon your practical operating experience and Clark's unique experience in the field of power transmission; working together to develop a better drive mechanism. Many alert, aggressive manufacturers have tried this well-tested plan of working with Clark—and discovered the Class that results in Dependability.

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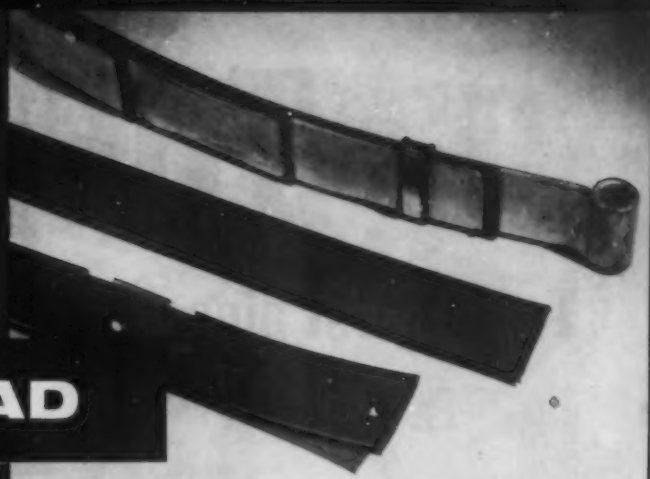
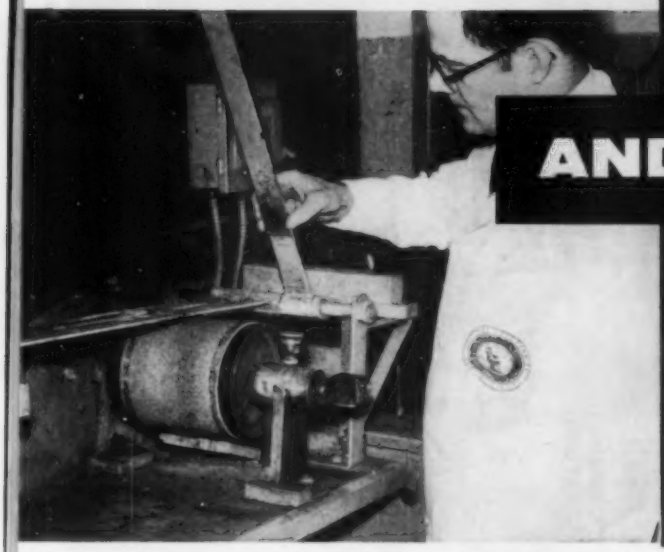


ON THE ROAD



AND IN THE LAB

Here's double proof of BAKELITE Polyethylene's

wear resistance

On the Road—BAKELITE Polyethylene proves its outstanding wear resistance when molded into automobile leaf spring liners. These "dry lubricants" fit tightly between the leaves, preventing squeaks caused by metal-to-metal contact. Their waxy surface is unaffected by hot or cold weather. Their molded flanges hold the leaves in line and seal out grit that can cause spring breakdown. These liners won't absorb moisture, and are unaffected by salt and other snow-melting chemicals.

In the Lab—the wear resistance of BAKELITE Polyethylene is shown by tests described in a report by the U. S. Testing Co., dated Sept. 24, 1953. In comparison with a well-known rubber-type compound, BAKELITE Polyethylene was tested by rubbing it against various surfaces with a rotary motion, a reciprocating motion, and a combination of both. The abrading agents were "Aloxite" 320 metal cloth, cold-rolled steel, and maple wood.

Conclusion stated that BAKELITE Polyethylene possessed "superior abrasion resistance." In one test, involving rotary motion, and employing "Aloxite" 320 as the abrading agent, BAKELITE Polyethylene lost 40 to 45 per cent of its thickness in 2000 revolutions, while the rubber-type compound lost 75 to 80 per cent in 280 revolutions.

Such evidence of the toughness and wear resistance inherent in BAKELITE Polyethylene indicates increased use of this material for molding and extrusion applications where service conditions will be severe. Complete details on the abrasion resistance tests are given in KABELITEMS No. 68. For your free copy, write Dept. TJ-10.

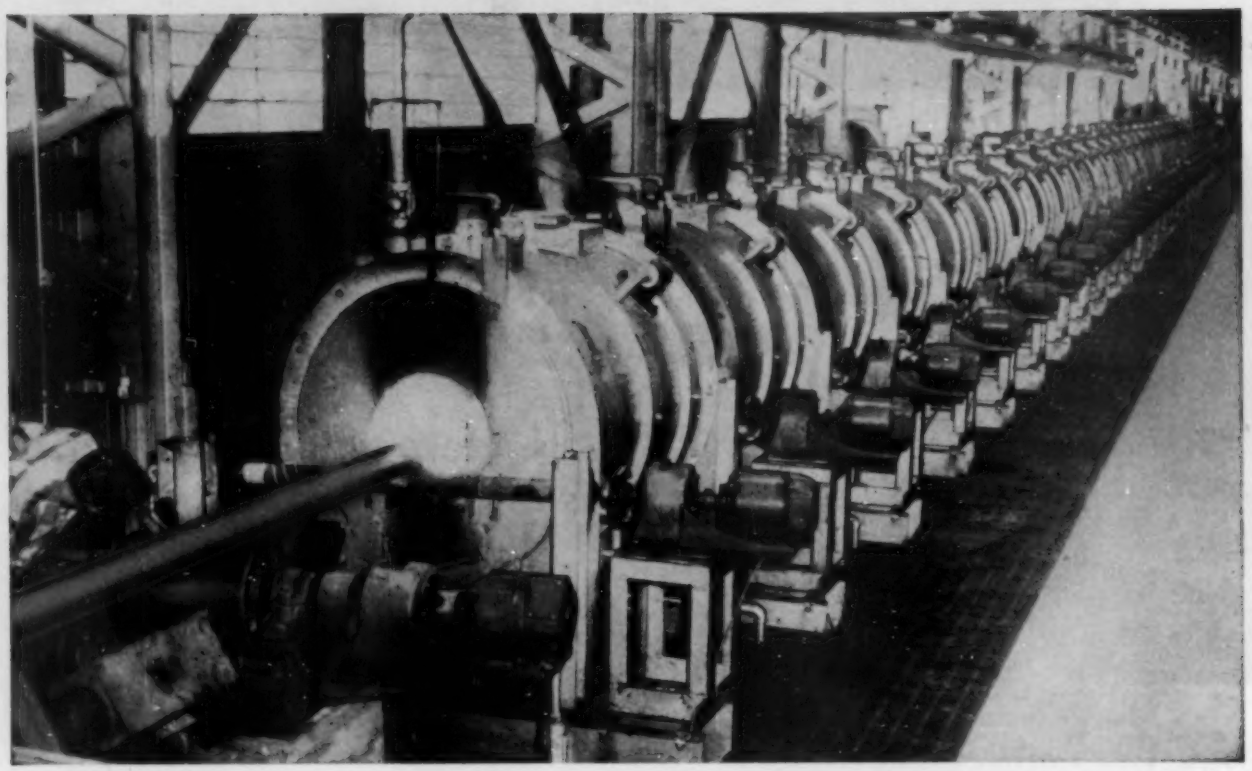
BAKELITE
TRADE-MARK
Polyethylene

BAKELITE COMPANY
A Division of Union Carbide and Carbon Corporation UCC
30 East 42nd Street, New York 17, New York

In Canada: Bakelite Company
A Division of Union Carbide Canada Limited
Belleville, Ontario

TOUGH JOB?

Texas' first pipe mill at Lone Star Steel chooses



As far as the eye can see—Link-Belt cast steel roller bearing pillow blocks and helical gear drive units on roller conveyors in No. 2 Pipe mill handling 6″ dia. pipe. No. 1 handles pipe up to 16″ dia. Link-Belt chains are used on cooling and transfer beds.

HIGH temperatures from heat-treating furnaces . . . heavy, continuous loads . . . frequent, severe impact. You'd have a hard time finding a tougher set of conditions for bearings. Yet that's exactly the combination encountered by the roller conveyor units in a pipe mill.

Three equipment manufacturers, who were awarded separate contracts for important conveying and handling equipment, independently specified Link-Belt bearings. This selection in all three cases was approved by the supervising engineers, A. J. Boynton and Company. Throughout the half-mile long production lines in Nos. 1 and 2 pipe mills, these rugged blocks with *cast steel housings* support the rolls and the pipe as it is formed, sized, straightened, threaded, tested, inspected, varnished and moved to yard storage.

For your toughest shaft support jobs, it will pay you to investigate the possibilities of these self-aligning roller bearings housed in cast steel. You'll discover the features listed on the page at right are just a few of their outstanding advantages. Ask your nearby Link-Belt sales representative for complete information.

LINK-BELT

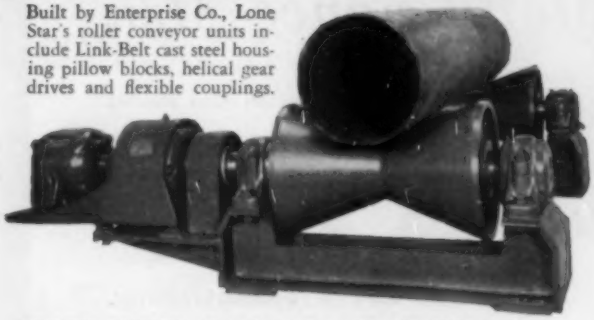
BALL AND ROLLER BEARINGS

LINK-BELT ball and roller bearings keep company with

READY ANSWER:

LINK-BELT BEARINGS

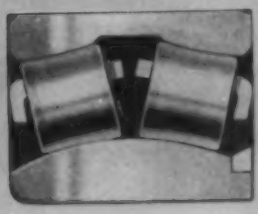
Built by Enterprise Co., Lone Star's roller conveyor units include Link-Belt cast steel housing pillow blocks, helical gear drives and flexible couplings.



LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices, Stock Carrying Factory Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.381-DIE

FACTS: for consulting and design engineers

New Link-Belt Series LPK-6800-F Roller Bearing Pillow Blocks have rugged cast steel housings with removable caps for easy assembly and disassembly.

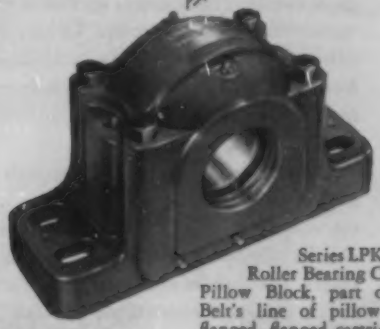


INTEGRAL SELF-ALIGNMENT. Concave rollers operate between convex raceways. Inner ring is true spherical element, free to turn in any direction without altering contact with rollers. Symmetrical rollers completely pocketed in retainers for accurate spacing and guiding. Long, care-free bearing performance is assured even with shaft deflection or misalignment.

SPIRAL STEEL SEALS provide effective lubricant retention for either oil or grease. Housing sealing fully protects all moving surfaces which are centrally lubricated from a large, common reservoir.

END PLATE can be used for protection where shaft terminates at the bearing. No added machining is necessary.

INCREASED COMPACTNESS is achieved with self-contained design. There are no external rotating parts to mar smooth appearance.



Series LPK-6800-F Roller Bearing Cast Steel Pillow Block, part of Link-Belt's line of pillow blocks, flanged, flanged cartridge, cartridge, take-up and hanger blocks and unmounted bearings.

America's hardest-working machines

ONE OF A SERIES

You Get Many Benefits
by Specifying VICKERS® Hydraulics

Hydraulics School for Customers' Own Service and Maintenance Men

Manufacturers who have Vickers Hydraulic Equipment on their machines can have their own service men trained in the Vickers Hydraulics School. Since its beginning in 1945, this school has trained more than 800 men from approximately 400 companies. There is no tuition charge for this training course.

These men are given a thorough schooling in hydraulic theory and practice . . . and in the operation and maintenance of Vickers Hydraulic Equipment. The benefits to manufacturers of Vickers-equipped machines are obvious. Of equal importance are the benefits to users of such machines who are thus assured of better maintenance.

Again, this is only one of many reasons why it pays to specify Vickers Hydraulics.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND DETROIT • HOUSTON • LOS ANGELES (Metropolitan) NEW YORK (Metropolitan) • ODESSA • PHILADELPHIA (Metropolitan) • PITTSBURGH • ROCHESTER • ROCKFORD SEATTLE • TULSA • WASHINGTON • WORCESTER

6393

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Mills all sides of aircraft fitting in 5 minutes flat . . . *with help of TIMKEN® bearings*

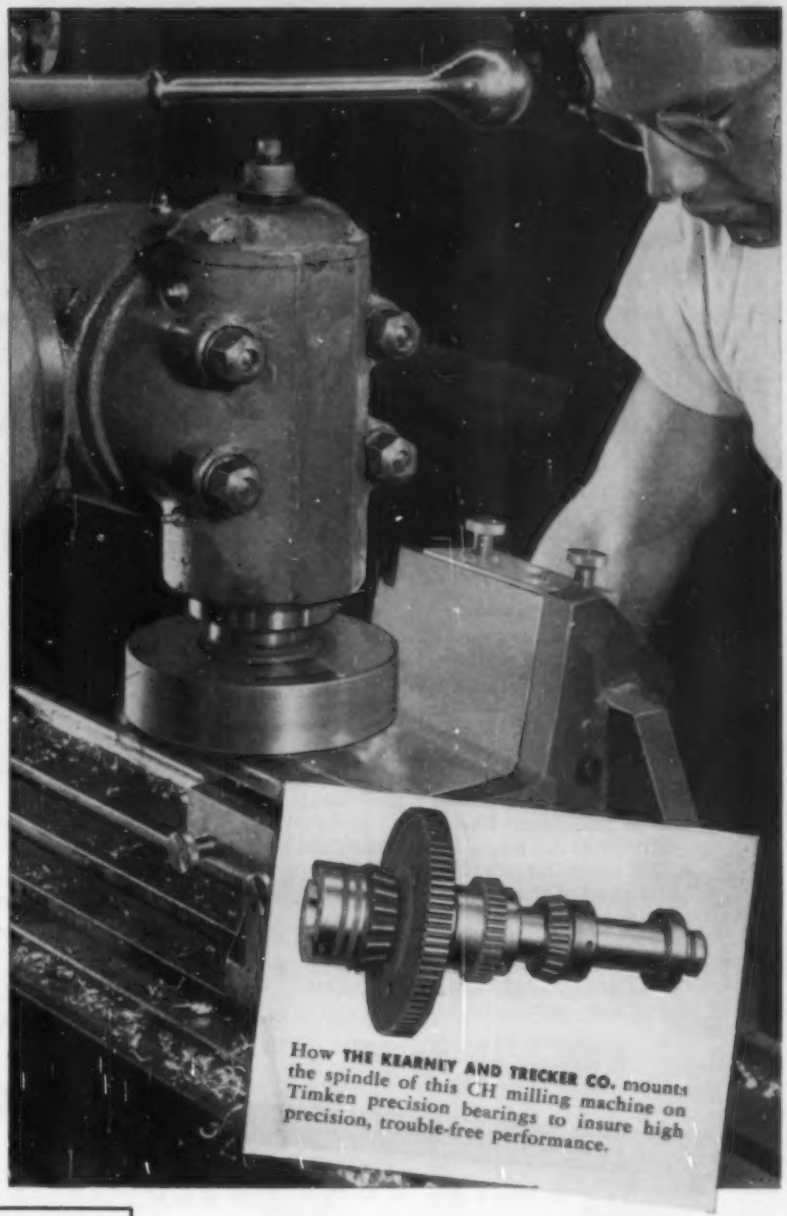
MAKING cuts .050" deep in 75ST aluminum alloy, this Kearney & Trecker Model CH milling machine mills all sides of an aircraft fitting in five minutes. Even at these high milling speeds, spindle rigidity is maintained—the spindle is mounted on Timken® tapered roller precision bearings.

Line contact between their rollers and races gives Timken bearings extra load-carrying capacity. Their tapered construction takes radial and thrust loads in *any* combination and permits fine bearing adjustment. Result: shafts are held in rigid alignment. Shaft deflection is minimized and end-play can be eliminated. Gears mesh smoothly. Spindle precision is assured.

Timken bearings' tapered construction also makes them easier and less costly to assemble. No auxiliary thrust washers are needed. Spindle maintenance is simplified.

No other bearing gives you all these advantages. Specify Timken precision bearings in the machine tools you build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How THE KEARNEY AND TRECKER CO. mounts the spindle of this CH milling machine on Timken precision bearings to insure high precision, trouble-free performance.

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

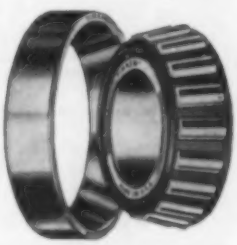
$$Value = \frac{quality + service + public\ acceptance}{price}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

TIMKEN

TRADE-MARK REG. U.S. PAT. OFF.

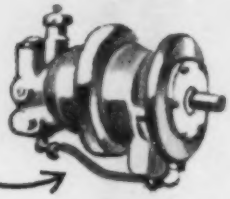
TAPERED ROLLER BEARINGS



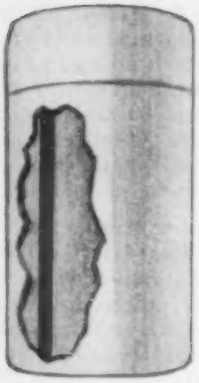
NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▱ BEARING TAKES RADIAL ▯ AND THRUST ▯— LOADS OR ANY COMBINATION ✳

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*

HIGH PRESSURE OIL PUMP LINES



FLINT HOLDER FOR CIGARETTE LIGHTER



THERMOSTAT FOR DEEP FAT FRYER

ADJUSTABLE CLOTHES RACK FRAME

REMARKS Baffled by a brand-new tubing headache? It may be old stuff to us. Our engineers have licked hundreds of tubing problems; may help lick yours. Why not let us put Bundyweld, plus our specialized engineering skills and unmatched fabrication facilities to work on your problem.

WRITE to us for catalog or for specific information on your problem.

BUNDY TUBING COMPANY
DETROIT 14, MICH.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Takes plating
Bright and clean
No inside bead
Uniform I.D., O.D.

Bundy Tubing Distributors and Representatives: ***Bridgeport, Conn.:*** Korhumel Steel & Aluminum Co., 117 E. Washington St. • ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.,*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., N.

Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

NATIONAL OIL SEAL LOGBOOK

Write our Redwood City office for reprints of this Logbook page

Sealing News & Tips

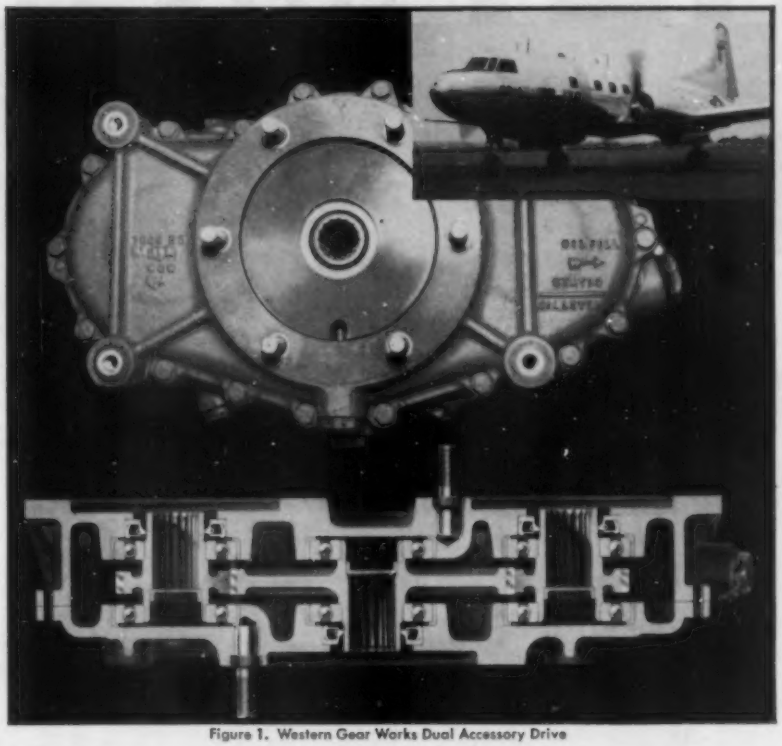


Figure 1. Western Gear Works Dual Accessory Drive

How Western Gear seals high-speed shafts in gear box of Convair radar trainer

A sound solution to oil sealing problems in high speed aircraft gear assemblies is found in Western Gear Works dual output accessory drive.

This unit drives a generator and alternator powering ten radar stations in the Convair radar instruction aircraft. The gear box is of magnesium, and designed for 2,000 hours operating life. Shaft speed at the output pads reaches 10,000 R.P.M., and operation is continuous. Lubricant is AN-0-3 oil, temperatures range from −65° to 250°F, and the entire assembly is subjected to constant external vibration.

Dependable operation and effective oil retention is assured by National Syntech* Oil Seals at three points. Seals used are National 50,000-S standard designs, with spring-tensioned synthetic rubber sealing lips.

National Syntech seals are ideal for applications where high speeds, temperature extremes, vibration, and minimum sealing torque are required. Seals in the Western Gear assembly represent but one of over 2,500 standard designs with Syntech and leather sealing members offered by National. For complete information on National Syntech or leather seals, or special seals for special applications, call or write the nearest National Field Engineer.

Figure 2. 50,000-S Syntech Oil Seal

*T.M. Reg.

Separating Oils, Fluids

In applications where fluids or lubricants must be separated within a housing, National 70,000-S Syntech seals are recommended. This design has twin sealing lips of synthetic rubber, precision-trimmed to a "knife-edge" for minimum torque, mounted opposed, and spring-tensioned for positive sealing. Syntech seals are capable of continuous operation at intermittent temperatures up to 250°F, speeds to 7,000 F.P.M. and run-out to .030 indicator reading.

External Design

For applications where the shaft remains stationary, the bore rotates, and centrifugal force would impair operation of a shaft seal, National 80,000 series spring-tensioned leather seals are recommended. Use of this external design seal frequently simplifies machinery design and makes possible easier assembly and re-assembly.

Free O-Ring Catalog

National also offers a complete line of commercial grade O-Rings in all standard sizes. Write for new National O-Ring catalog which lists all rings, includes information on design, application, performance, back-up rings, etc.

"Let Your Decision be Based on Precision"

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

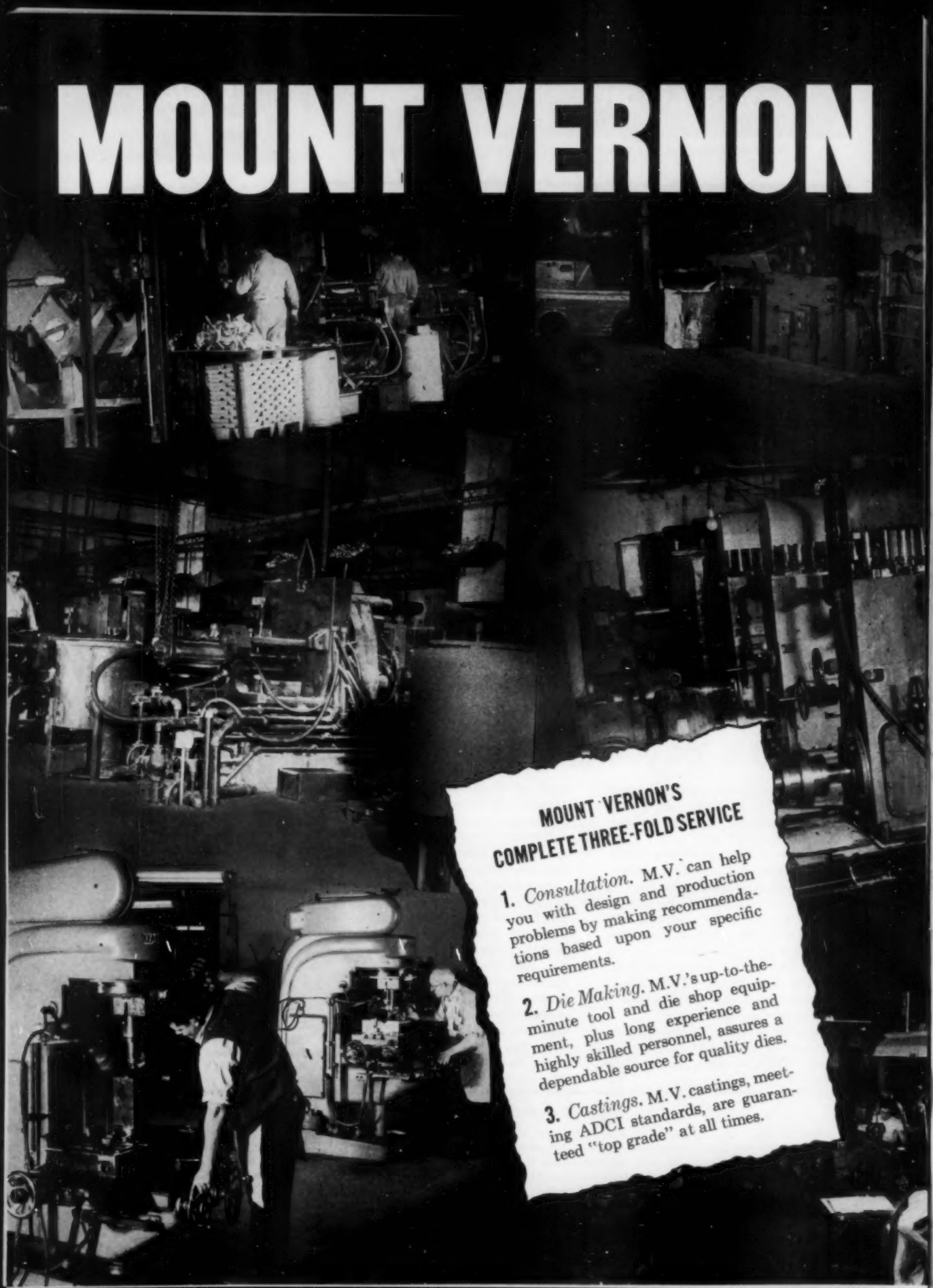
NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2962

CALL IN A NATIONAL APPLICATIONS ENGINEER

CHICAGO, ILL. . . . *Room 4113 Field Building, FRanklin 2-2847*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpas 2-8166*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF. . . *Broadway and National, EMerson 6-3861*
WICHITA, KANSAS . . . . *519 South Broadway, WIchita 2-6971*

MOUNT VERNON

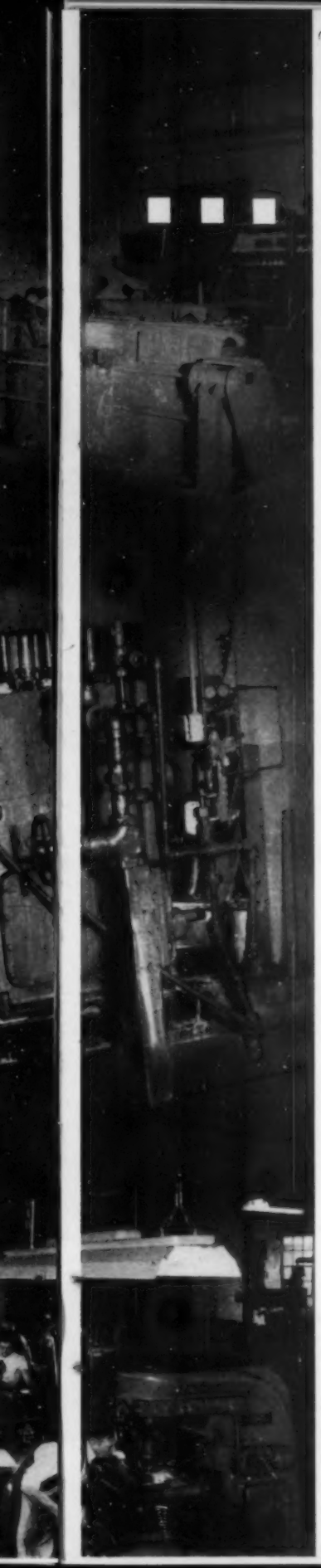


MOUNT VERNON'S COMPLETE THREE-FOLD SERVICE

1. *Consultation.* M.V. can help you with design and production problems by making recommendations based upon your specific requirements.

2. *Die Making.* M.V.'s up-to-the-minute tool and die shop equipment, plus long experience and highly skilled personnel, assures a dependable source for quality dies.

3. *Castings.* M.V. castings, meeting ADCI standards, are guaranteed "top grade" at all times.



an honored name... in a NEW HOME

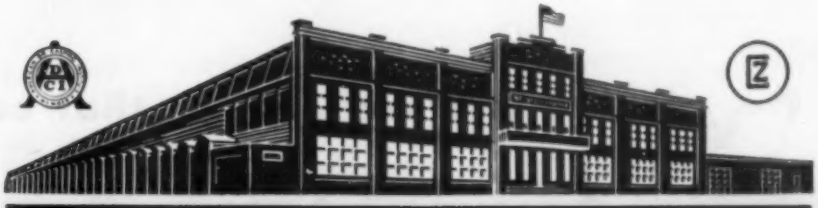
THE MOUNT VERNON DIE CASTING CORPORATION is now located at Stamford, Connecticut.

The reason for our moving is simple. You, our customers, have been so generous in your approval of our work, that we need more space to serve you adequately. We have found it in the spacious all-concrete building you see below, which has 165,000 sq. ft.—double the floor space of our former quarters.

Our new home is a wholly self-contained unit. In it we have ample room for our engineering department; for our complete tool and die shop; for our new, revolutionary zinc set-up; for an advanced design aluminum set-up operating integrally with two automatic electric furnaces, completely separated from the zinc division; for our forty die-casting machines, our finishing division, our modern metal recovery plant, as well as storage space for both dies and metals.

So we are now working in new physical surroundings—but one thing remains unchanged: Our determination, unvarying since 1905, through quality die casting to help *you* build even finer products at ever lowered costs.

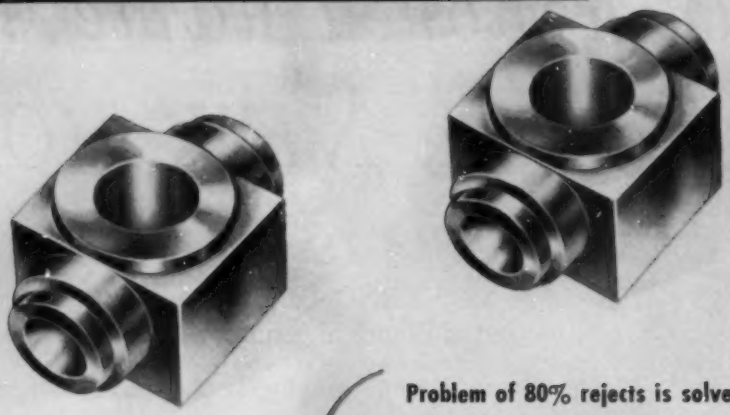
Yes, we take pride in our new home—but we shall judge it by the measure of its success in serving you.



MOUNT VERNON Die Casting Corp.

STAMFORD, CONNECTICUT

2 Stainless Parts . . . *look alike*



but with 1 of them

Problem of 80% rejects is solved

This is a precision part for a military bombsight. Some of the tolerances are ±.0001". Dependability is a "must". Every factor has to be "on the nose". Yet when the subcontractor used several ordinary Type 416 Stainless steels, rejects ran as high as 80%. But then he made one change . . . to Carpenter No. 5 (Type 416) . . . and eliminated the problem.

Tool life increases

Also, tool life was short, machine downtime excessive, and production was lagging. Then one change was made—to Carpenter Stainless No. 5—and machining time was shortened, tool life raised to a trouble-free level.

Production jumps

With Carpenter No. 5 production of this part is up to schedule because the reject problem has disappeared, machining time stepped up and tool life increased. Here is just one more example of how *Carpenter quality* makes a real difference in stainless fabrication. The next time you order stainless, be sure it's Carpenter. Watch it speed production—ease headaches from first operation to the last.

Make the one change that counts . . .

change to *Carpenter* STEEL

Free-Machining Stainless

take the problems out of production

THE CARPENTER STEEL COMPANY, 117 W. Bern St., Reading, Pa.
Export Department: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

For fast delivery, call your nearest Carpenter Mill-Branch Warehouse, Office or Distributor

NOW– NEMA Type XII

THE ONLY SAFETY SWITCH IN SPECIAL INDUSTRY ENCLOSURE!

CAPTIVE SCREWS assure tight cover fit
EXTERNAL MOUNTING FEET eliminate need for conventional leaky mounting holes within the enclosure
NEOPRENE GASKET provides positive cover seal
WELDED TIGHT ENCLOSURE without knockouts excludes dirt, dust, oil, and splashing coolant

This new heavy duty switch, built to NEMA XII specifications, is "tailor-made" for applications requiring the exclusion of dirt, dust, oil and coolant.

The rugged, visible-blade switch mechanism within the special industry enclosure has all the performance features that have made Square D an overwhelming "first choice" for fifty years.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

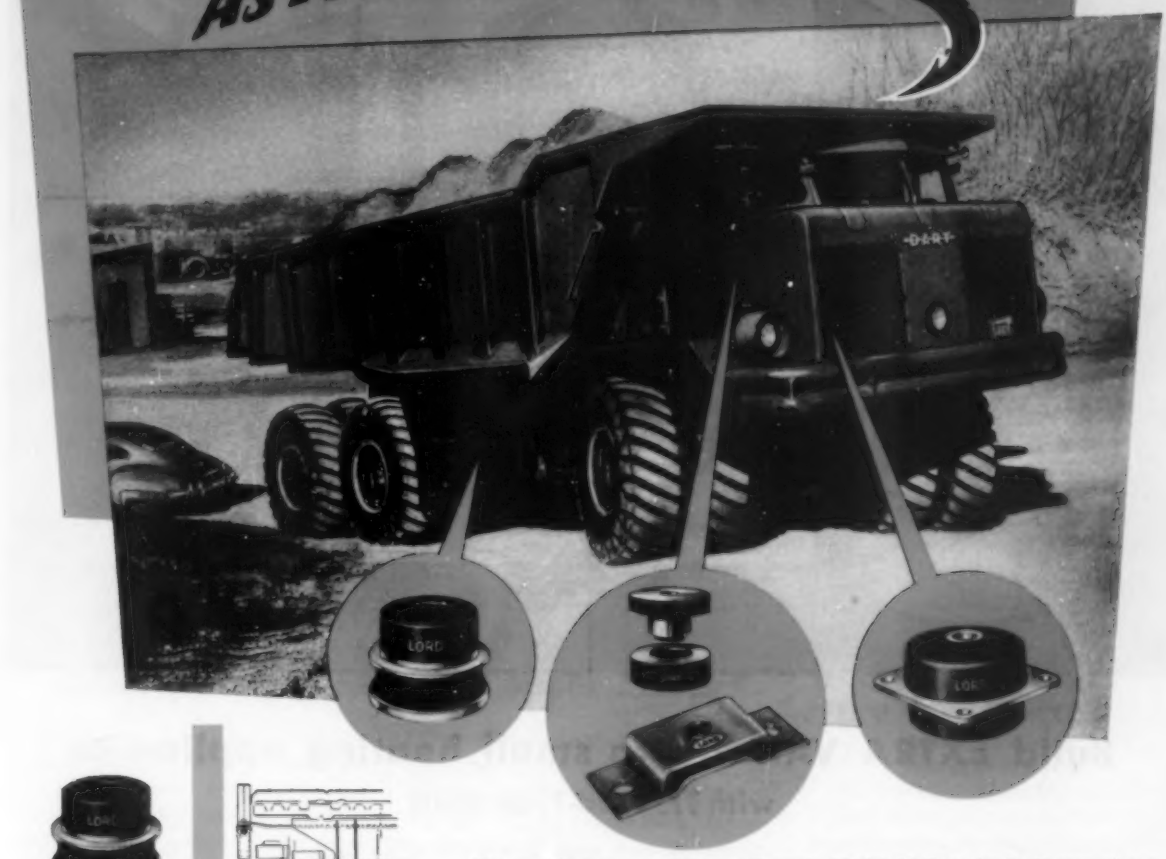
...more than just a pipe dream

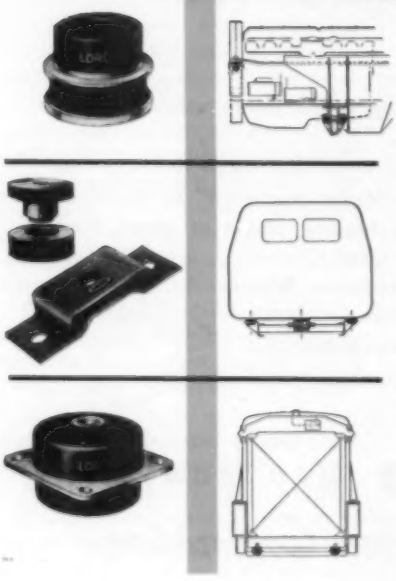
AWQ, symbol — American Welding Quality is a very real — and a very serious thing to the men in our shop. Perhaps AWQ can best be expressed as the pride these craftsmen have in their work. AWQ makes each man a critical inspector of his own work — be it forming, welding, machining, assembling — or any one of the other jobs involved in producing rings, bands, and welded assemblies.

For complete welding and machining facilities backed up by conscientious craftsmanship and know-how gained from supplying all types of weldments to American Industry — write us today. Our Product Development Division will be glad to apply 35 years of experience to the study of your particular problem.

THE AMERICAN WELDING & MANUFACTURING COMPANY • 140 DIETZ ROAD WARREN • OHIO

LORD Bonded-Rubber Mountings... As Rugged As This





The world's largest "off-the-road" truck, Model 60 Dart, hauls 60 tons of copper ore from the huge shovels in the pits of The Bagdad Copper Mines of Bagdad, Arizona to the mine rim over tortuous, twisting, climbing roadways impossible for any other means of transportation. Contributing to the desired performance of this mammoth vehicle, Lord Bonded-Rubber Mountings cushion the twin radiators against vibration and shock, thus protecting the vital cooling system and reducing maintenance costs.

The two 350 hp. diesel engines and transmission assemblies are protected from the shocks of rough going by Lord Mountings . . . these same mountings provide a barrier between damaging engine vibration and the truck itself. To complete the job Lord Mountings protect the cab.

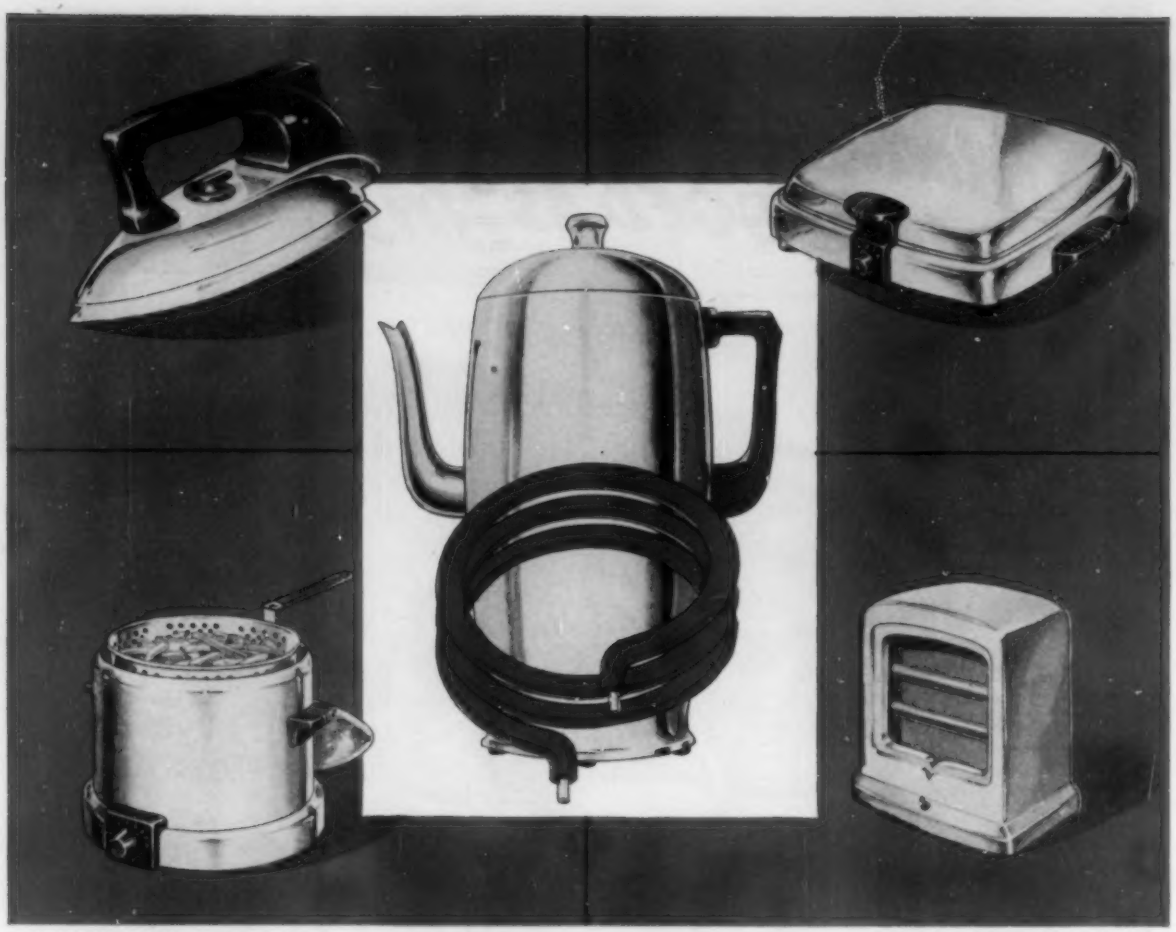
As rugged as the products they protect, Lord Bonded-Rubber Parts are used every day to improve the performance of industrial products large and small . . . Let us work with you.

LOS ANGELES 28, CALIFORNIA 7046 Hollywood Boulevard
DALLAS, TEXAS 313 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 311 Curtis Building
NEW YORK 16, NEW YORK 280 Madison Avenue
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
CLEVELAND 15, OHIO 811 Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for
VIBRATION CONTROL



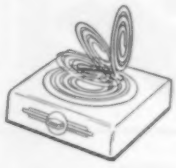
Build EXTRA VALUE into small heating appliances

with TK® Rod-Type Units

It costs but little more to make a *real selling feature* of the heating element in your small appliances. And what could be more important to the ultimate buyers . . . or to your dealers . . . than the *heating unit* in such products, literally the "key" to long-time user satisfaction?

With just a little help from you, your dealers can easily capitalize on the extra value put into such products. It gives them something to point up in their selling, something to justify the price they are asking.

TK Rod-Type Units last longer because the heating coil is firmly "anchored" in rock-like oxide within a lifetime jacket of metal. And you'll find they speed up your assembling operations. Why not drop us a line and let us show you how we can help put extra value in *your* products?

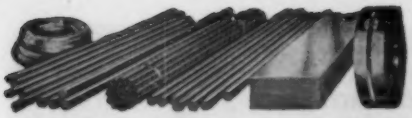


TK FERRO

FERROD MFG. COMPANY

A Subsidiary of Ferro Corporation

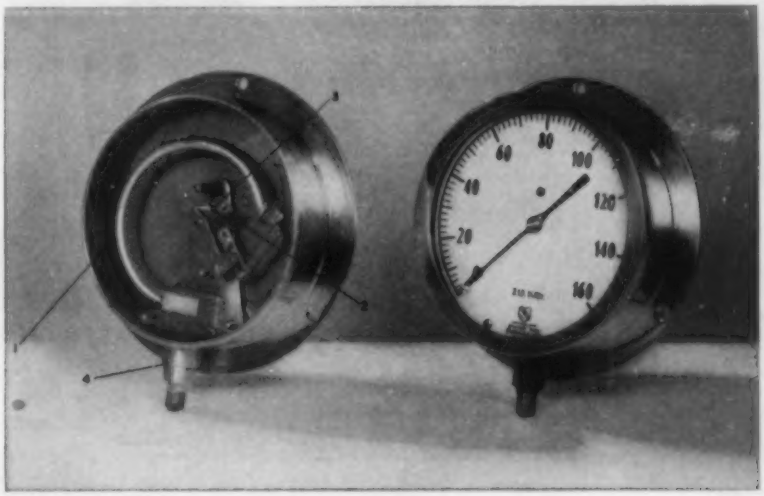
605 N. RIVER ST. • BATAVIA, ILL. • PHONE 6240



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Interior of Ashcroft Duragauge at left shows where copper-base alloys are widely used because of their dependability and corrosion resistance. Brass and Bronze are especially important at the following key points: (1) Bourdon Tube, (2) Gear Segment, (3) Rotary Geared Movement, (4) Socket. Courtesy of Manning, Maxwell & Moore, Inc., Stratford, Conn.

Quality Gauges Rely on Copper Alloys

How many of us realize the importance of dependable gauges which are so vital to modern living. Wherever there's a need for accurate measurement, you'll find gauges. In fact, there are applications beyond number where gauges automatically safeguard lives, equipment, and uniformity of product.

Just as gauges are essential to the making of many things, copper-base alloys are vital to the accuracy and dependable performance of their sensitive yet rugged components.

Quality gauges designed for air, water, steam, oil and other media use high corrosion-resistant copper alloys because accurate readings are imperative in spite of constant surges, fluctuations, pulsations, vibrations, and corrosive attack encountered in service.

In the pressure gauge illustrated, one of the most important parts is the curved Bourdon tube whose elliptical shape and the accuracy of the tube-wall curvature, as well as the physical properties of the metal, are all very critical.

As pressure is applied inside the Bourdon tube, it tends to straighten out, resulting in deflection of the free end of the tube. This end of the Bourdon tube is linked to the gear segment in mesh with the pinion gear that moves the pivot shaft to which the pointer is attached. The amount of motion is transmitted to the pointer which moves over a calibrated scale and indicates the applied pressure.

The temper and spring characteristics of the metal in the Bourdon tube prevent it from becoming "set" after repeated flexing. Any change in its physical characteristics or corrosive attack would affect the accuracy of the gauge. Consequently, copper-base alloys are widely used in gauge construction, which comprises the rotary geared movement that is actuated by the Bourdon tube, the socket, plates, segment, columns, pivot shafts, pinion gear, hair spring, bushings, link and link screws, and closing end for the tube and the case.

Phosphor Bronze Widely Used in Rotary Geared Movement

Phosphor Bronze, Grade A, long known for its excellent spring properties, its fine resistance toward fatigue and corrosion is generally used for Bourdon tubing for pressure gauges designed for medium and low pressures and vacuum measurements. This alloy contains about 95% copper, and 5% tin.

In some instances, Alloy 21, which contains approximately 81% copper, 1.1% tin and balance zinc, is used for making Bourdon tubing for low pressure steam gauges.

Phosphor Bronze, Grade A, is also used for the hair spring, which takes the back lash out of the rack and pinion assembly.

The gear segment bushing and link screws are also made from Phosphor Bronze on the higher quality instruments, although leaded brass is very often used for these applications.

Leaded Brass for Ease of Machining

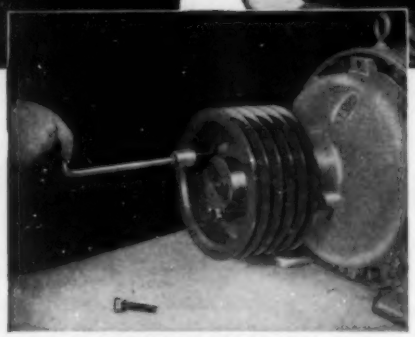
The plates, blanked, pierced, drilled, reamed and tapped, are made of clock brass for clean, sharp blanking and free machinability. This contains about 62% copper, 2% lead, and balance zinc. The socket, into which the Bourdon tube is mounted and on which the movement is attached, whose end is threaded for pipe connection, is square free-machining brass rod, Alloy 6—copper about 61%, lead 3.4%, zinc remainder. Drilling, turning, milling, threading and tapping are done at great speeds on this high-leaded alloy.

Laboratory Service Available

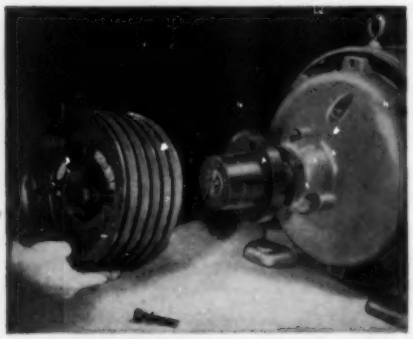
The selection of the correct material for all types of products can be simplified by contacting our nearest district office for information. Machining, corrosion and other problems are discussed in our "Technical Handbook," a copy of which will be sent to you on your request. Be sure to write for your copy on your company stationery.

(1290)

"O.K., GEORGE. YOU'VE CONVINCED ME THAT A TWO-PIECE SHEAVE GRIPS TIGHTER, BUT I DON'T SEE WHAT DIFFERENCE IT MAKES HOW IT'S ASSEMBLED."
"THE QD IS ASSEMBLED RIGHT ON THE SHAFT, CHARLIE. THAT WAY THE HUB STAYS PERMANENTLY ALIGNED. YOU MERELY REPLACE THE RIM TO CHANGE SPEEDS."



ONLY THE RIM COMES OFF. This is done by using the heavy assembly bolts as jack screws. Then the sheave slides easily off the tapered hub. No time-consuming prying or hammering is required.

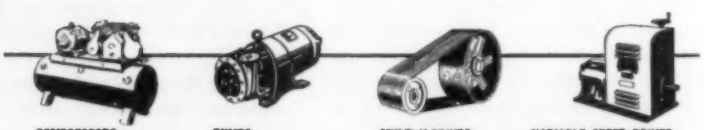


THE HUB STAYS PUT—there's no need to remove it when changing speeds. When you've finished the job, you just replace the rim over it and tighten the bolts. Alignment is *permanent*.

"How it's assembled" makes a big difference when you're choosing sheaves!

Because the famous Worthington QD can be assembled and disassembled right *on the shaft*, your maintenance man can change speeds merely by changing rims. The previously aligned hub need not be touched.

On initial assembly, holding alignment of the hub is a snap. All you do is tighten the flange cap screw after positioning the hub along the shaft. Drifting of the key is prevented by tightening the set screw over the key.



COMPRESSORS: AIR-COOLED, WATER-COOLED

PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER

MULTI-V-DRIVES: QD SHEAVES AND V-BELTS

VARIABLE SPEED DRIVES: WORTHINGTON ALLSPEED

You don't have to wait for Multi-V-Drive Equipment

WORTHINGTON-GOODYEAR EC CORD V-BELTS are the only belts available with a single parallel row of low-stretch, high tensile, heavy cord to withstand high flexing abuses required of short belts. Tire cord ply construction insures proper transverse rigidity on longer V-belt drives. Steel Cable V-belts and HY-T Super Rated V-belts will handle really tough drives. Prompt service on the complete line.

Worthington stocks a complete line of QD Sheaves, small V-pulleys, and Worthington-Goodyear EC Cord V-belts

Your local Worthington Multi-V-Drive distributor has a complete line of Worthington QD Sheaves, fractional horsepower V-pulleys and Worthington-Goodyear V-belts. He's backed by large factory stocks that enable him to fill your order *immediately*.

The Worthington fractional horsepower line of V-pulleys includes:

The QD Junior V-Pulley that will grip the shaft tighter than any other V-pulley now available. Its tapered hub is forced tight on the shaft and won't loosen due to shock or vibration.

Machined Steel V-Pulleys—3½ inches and under—precision-bored for proper fit. Grooves are accurately cut to provide proper seating of the belt for longer wear.

Pressed Steel V-Pulleys of heavy gauge welded steel. Equal weight distribution assures accurate balance and vibrationless operation.

Cast Iron Bored-to-Suit V-pulleys accurately machined for true running and perfect balance. They come in a full range of sizes with one or two grooves.

For prompt deliveries, or further information on any Multi-V-Drive equipment, write to Worthington Corporation, Section MV.3.2, Oil City, Pennsylvania. MV.3.2

Specify These Worthington Standard Products on Your Equipment

WORTHINGTON

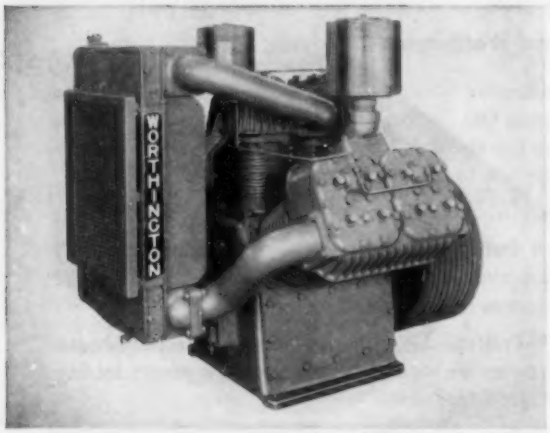
COMPRESSED AIR...
do you get it economically?

FOR SMALLER QUANTITIES of compressed air, Worthington's Balanced Angle Compressor is your best bet. Mills, machine shops and laundries all over praise the quietness and efficiency of this dependable unit. Sizes range from ⅓ through 15 hp.

If you can't answer this one, you might find some investigation worthwhile.

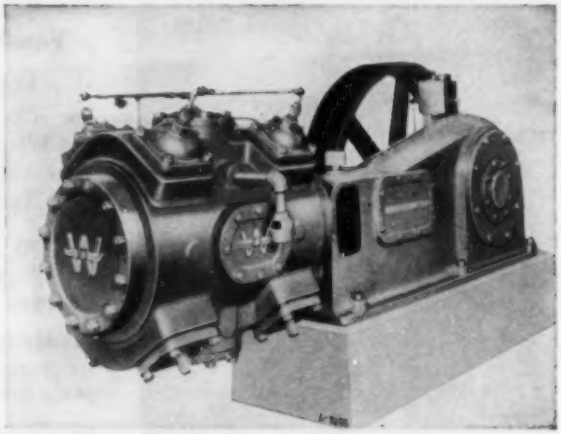
When is a compressor worn out? What model and horsepower is the best answer for your application? How much reserve capacity should you allow for?

Providing the answers to these and other questions about air compression is all in the day's work for Worthington. We've got the widest line to choose from, so you'll know any new Worthington equipment you get is "right" for your particular job.



COMPACTNESS AND EASY INSTALLATION are the big advantages of Worthington Radial Air Compressors, used where larger quantities of air are needed. Like all Worthington compressors, the radial is equipped with our exclusive Feather* Valve. Sizes from 25 to 100 hp.

*Reg. U. S. Pat. Off.



FOR THE REALLY BIG JOBS, specify the horizontal, water-cooled HB—the work horse of the Worthington compressor line. We've had reports about 30-year-old HB's that are giving the same good service as when first installed. Sizes from 7½ on up to 125 hp.

Get the whole story about these modern compressors. Write for Bulletin WP-1099-B52 to Worthington Corporation, Pump and Compressor Merchandising Division, Harrison, New Jersey.

WORTHINGTON

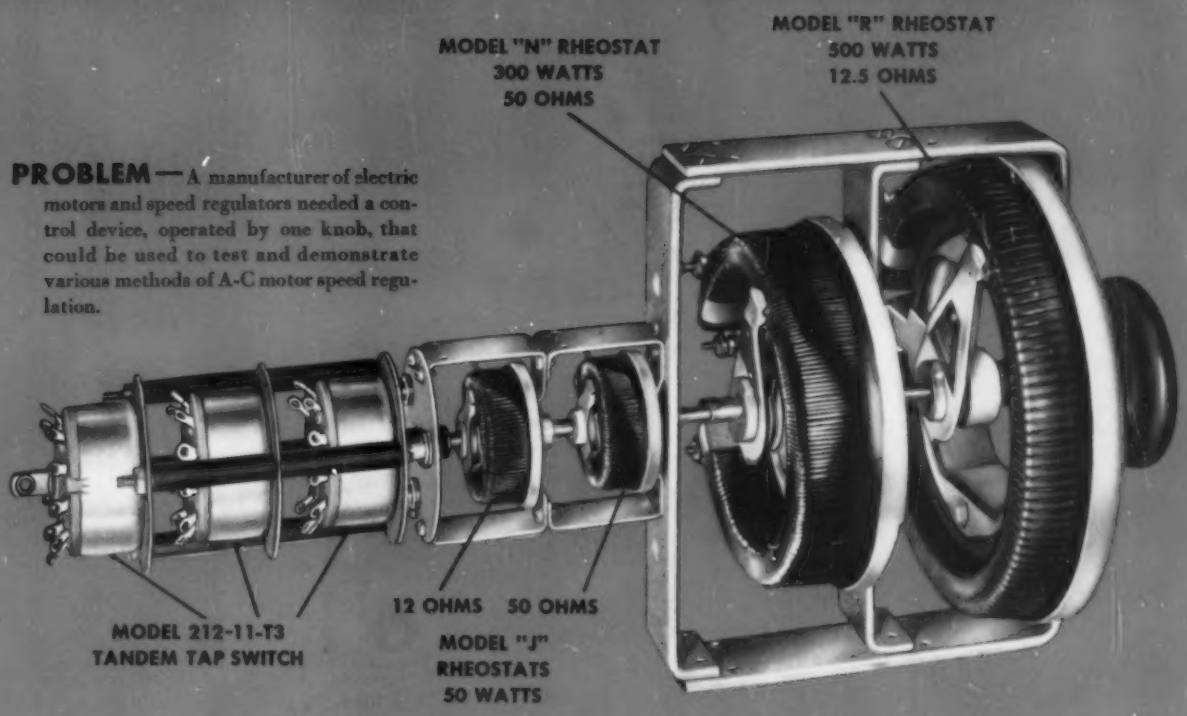
PC.3.14

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors · Pumps · Multi-V-Drives · Variable Speed Drives

OHMITE®
RHEOSTATS
in Special Tandem Assemblies

MADE TO ORDER TO SOLVE YOUR UNUSUAL CONTROL PROBLEMS



PROBLEM—A manufacturer of electric motors and speed regulators needed a control device, operated by one knob, that could be used to test and demonstrate various methods of A-C motor speed regulation.

SOLUTION—Ohmite produced a special combination of four rheostats and three 11-position switches, all coupled together in tandem, and operated by one knob. The tap switches are loosely coupled to the rheostats so when the quick-make taps close, the rheostat settings are not changed. All units are electrically independent. Any unit or all units can be connected in the circuit to be tested, and can be wired in any desired manner. As a result of this special control device, test and development work was greatly speeded up.

Ohmite is prepared to develop special combinations of standard rheostats, resistors, and tap switches to meet your individual requirements. Consult your Ohmite representative.

BE RIGHT WITH OHMITE®

RHEOSTATS • RESISTORS • TAP SWITCHES

What Special Feature do you need in a RHEOSTAT?

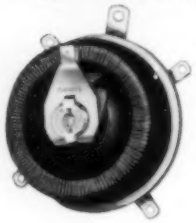
OHMITE CAN SUPPLY IT!

In addition to standard rheostats, Ohmite offers rheostats with a wide variety of *special features*. All have the distinctive Ohmite design features: smoothly gliding metal-graphite brush; all-ceramic construction; insulated shaft and mounting; windings permanently locked in place by vitreous enamel.

BUSHINGS FOR SPECIAL PANEL THICKNESS

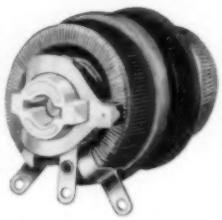
Extra-long bushings and shafts allow mounting on panels up to 2 inches in thickness. Seven bushing lengths are available, from ¼ to 2⅛ inches.

360° WINDING



Two small models available with continuous circular core and endless winding. Unlimited rotation of shaft and contact arm. Taps supplied at any desired angle on windings.

DEAD LUG OFF POSITION



Opens the circuit at the high or low resistance position as the contact passes on to the lug, which is disconnected from the winding. Recommended for light duty.

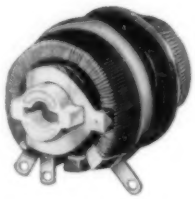
SCREW DRIVER SLOT SHAFT

Where infrequent adjustments are needed, shaft ends can be slotted for operation with a screwdriver. Tampering with the shaft setting is thus minimized.

SEALED, ENCLOSED CAGES

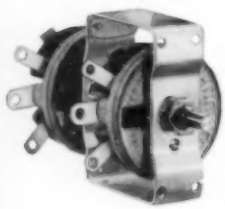
Compact, corrosion-resisting metal enclosure, permanently sealed by a double seam, protects the unit completely. Available with rheostat Models H and J.

SNAP-ACTION OFF POSITION



Opens the rheostat circuit at the high or low resistance position. The circuit is opened as the brush snaps into an insulated notch next to the lug, providing indexing.

TANDEM ASSEMBLIES

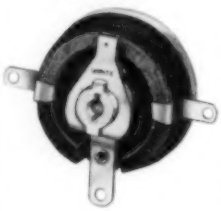


Ohmite rheostats can be mounted two or more in tandem, for simultaneous operation of several circuits. Universal joints provide smooth, positive mechanical action.

TOGGLE SWITCH

Toggle switch is operated with a positive snap by the movement of the contact arm. Opens the rheostat circuit or switches an independent circuit. Available for all models.

LESS THAN STANDARD ROTATION



Rheostats can be supplied with winding space and angle of rotation less than standard. Rheostats can also be supplied with fixed or adjustable stops.

OHMITE MANUFACTURING COMPANY
3611 Howard St., Skokie, Illinois (Suburb of Chicago)

WRITE on Company Letterhead for Catalog and Engineering Manual No. 40.

Be Right with

OHMITE®

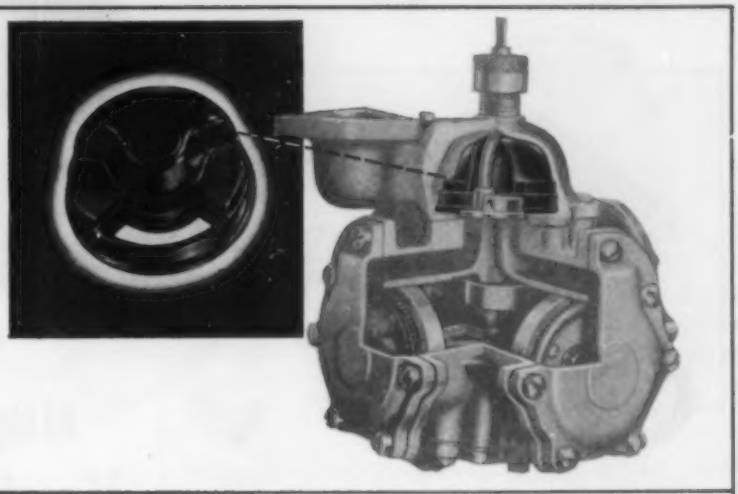
RHEOSTATS • RESISTORS • TAP SWITCHES

WHAT EVERY ENGINEER SHOULD KNOW ABOUT CARBON

Carbon Products Offer Distinct Advantages

Design engineers have profited greatly from the constant development of carbon in industrial applications. For more than 30 years Morganite has continued to explore the possibilities of carbon. Morganite's findings have revealed properties inherent in carbon which, when applied to industrial machinery, simplify design, reduce maintenance costs, and add life to vital equipment.

Today, bearings, valves, valve seats, vanes, gland rings, piston rings, slides and seal noses, all made of carbon, are commonplace. Tomorrow will bring new ideas, extending the use of carbon in industrial design.



Morganite developed and tested a self-lubricating rotary valve suitable for gasoline metering. Tests indicated a 90% reduction in operating troubles formerly due to friction, gumming or sticking.

Carbon Has Unique Features

Unlike metals, carbon needs no oil. The graphitic content of carbon component parts supplies all the lubrication required to operate smoothly and efficiently, even when submerged in water, acids, or other liquids. Carbon will not corrode. It is resistant to most chemicals, alkalis, solvents, gasoline and water.

Morganite carbon will withstand high temperatures and thermal shock. It will retain its strength and hardness under almost any condition.

Morganite carbon is particularly well adapted to the food and chemical industries where freedom from contamination is vitally important. Carbon will not give off unwanted odors or tastes.

Carbon Can Be Accurately Machined

Morganite carbon can be machined to accurate limits and lapped flat to 3 light bands. It can be plated, cemented, or can be permanently vulcanized to natural or synthetic rubber. It can be coated with porcelain or other ceramic material.

Most applications possess distinctive characteristics. To provide exceptional performance for each particular type of service, several grades of Morganite have been developed. When considering the use of a carbon part, it is important to take into account speed and load-radial or axial, the material to be handled, pressures and temperatures, as well as the type of material to which the carbon will be mated. A discussion of these details with a Morganite service engineer will be helpful.

Literature On Request

To help design engineers in solving their many and varied problems, Morganite will be glad to send, without obligation of course, its DESIGN DATA REFERENCE. This brochure contains hints in designing with carbon, charts and other usable data needed in considering carbon applications.

Morganite technicians have many years of experience in developing carbon applications. Their knowledge will be found invaluable. If you desire, they will be glad to discuss your design problems with you.

Write Today For

Morganite Design Data Reference—describes advantages, lists chemical and physical properties, gives hints on design. No obligation.

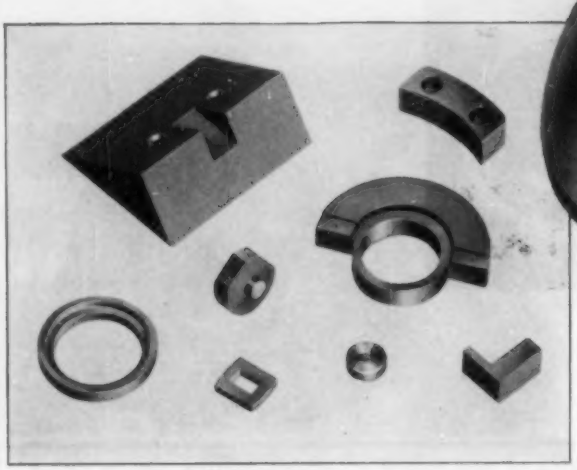
MORGANITE INCORPORATED
3306 48th Avenue, Long Island City 1, N. Y.

Gentlemen:
Please send me, without obligation, a copy of Morganite's new brochure, DESIGN DATA REFERENCE.

Name_____
Title_____
Company_____
Street_____
City_____ State_____

This Counter Balance Gained Weight...

Without Getting Larger!



Mallory 1000 High Density Metal *May be Your Answer, Too*

ONLY MALLORY 1000 METAL HAS THESE CHARACTERISTICS

- A tungsten-base alloy weighing 16.96 grams per cubic centimeter.
- High tensile strength . . . 105,000 lb. per square inch.
- High modulus of elasticity. No objectional drift at rotational speeds as high as 40,000 rpm.
- Excellent machinability. Surface finishes from 10 to 40 microinches, depending on method. Performance and chip form similar to gray iron.

Mallory 1000 is also highly effective as a radiation shielding material.

This counter balance for a motor driven radar antenna is an excellent example of how Mallory 1000 Metal packs more weight into a given space.

With a density more than twice that of steel or brass, with far greater strength than lead, Mallory 1000 Metal should be considered for use in balance weights and rotors whenever space is a factor.

In addition to important savings in space, you will also profit by Mallory's contour pressing technique which produces intricate shapes to close tolerances that minimize finish machining.

For complete specifications and characteristics, write for Technical Bulletin 6-7. It may be your answer for an improved product.

Expect more . . .
Get more from **MALLORY**

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

Can you use these new self-locking Nuts?

Designed for special applications . . . Do they suggest solutions to *your* design problems?

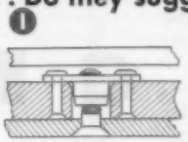
1 TWO-LUG INVERTED ANCHOR NUT For use where clearance or other considerations make it necessary to mount the nut upside down. Clearance hole must be provided for the barrel. Nylon inserts.

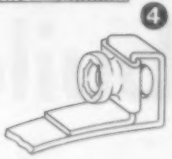
2 LIGHT HEX NUT, KEL-F INSERT Special KEL-F insert provides the self-locking, vibration-proof features of all ELASTIC STOP® nuts, for operation under extremely corrosive conditions—or exposed to strong acids—such as fuming nitric.

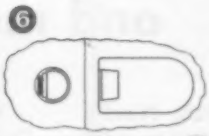
3 TWO-LUG HIGH-TENSILE ANCHOR NUT For use with 160,000 psi bolts, in blind mounting or in applications where ease of maintenance makes an attached nut desirable. Nylon inserts.

4 SELF-LOCKING CLAMP NUT For installation around the clamp leg, or on slotted strips where a random lengthwise positioning of the nut is necessary. Red nylon locking insert.

5 HIGH-TEMPERATURE, CLOSE CLEARANCE DOUBLE-HEX NUT For applications where weight, wrenching area and elevated temperatures are all major considerations. Temperatures to 1200° F.







6 LIGHTWEIGHT BARREL NUT Barrel nuts permit the use of lighter forgings—and simplify machining. "Bathtub" type recesses are necessary for the bolt head only, since the barrel nut fits into regular drilled hole. Wrenching is simplified because the nut cannot turn. This is a lightweight version of the ESNA high-tensile barrel nut, for 160,000 psi bolts. Nylon inserts.

7 ACCESSORY MOUNTING NUT High-temperature nut for mounting generators or similar accessories having a keyhole-type mounting flange. Large base diameter compensates for seating area lost to slot in flange. Nut straddles slot without Brinnelling the flange. Temperature to 550° F.

8 HIGH-TEMPERATURE FLOATING-BASKET ANCHOR NUT Specially designed for applications where a lesser degree of accuracy in alignment of nut and bolt hole is desirable. To 1200° F.

Mail coupon for design information

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N 48-22, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send details on the following fasteners:

☐ 1 ☐ 3 ☐ 5 ☐ 7
☐ 2 ☐ 4 ☐ 6 ☐ 8

☐ Here is a drawing of our product. What self-locking fastener do you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

Singer's New Slant-Needle Model — First machine that's a cabinet *and* portable all in one. First with the needle slanted to make it easy to see and guide the fabric. Finished in soft beige or traditional black.

How **Doehler-Jarvis** Helped Singer Develop ...a **new** way to build precision

and make a fine product

Have you seen Singer's new "Slant Needle" Model... the sewing machine designed to make home sewing easier and more convenient?

In one minute it can throw up to 1,500 stitches into your lady's crinolines. It's the only combination portable and cabinet model on the market. (Conversion from one type to the other takes only seconds.) Yet the machine, including motor, weighs under 17 pounds.

Singer can tell you that it's quite a chore to build such features into a machine like this . . . and still keep it competitive. And they're frank to give Doehler-Jarvis major credit for making their job easier with a new method for designing and producing precision parts.

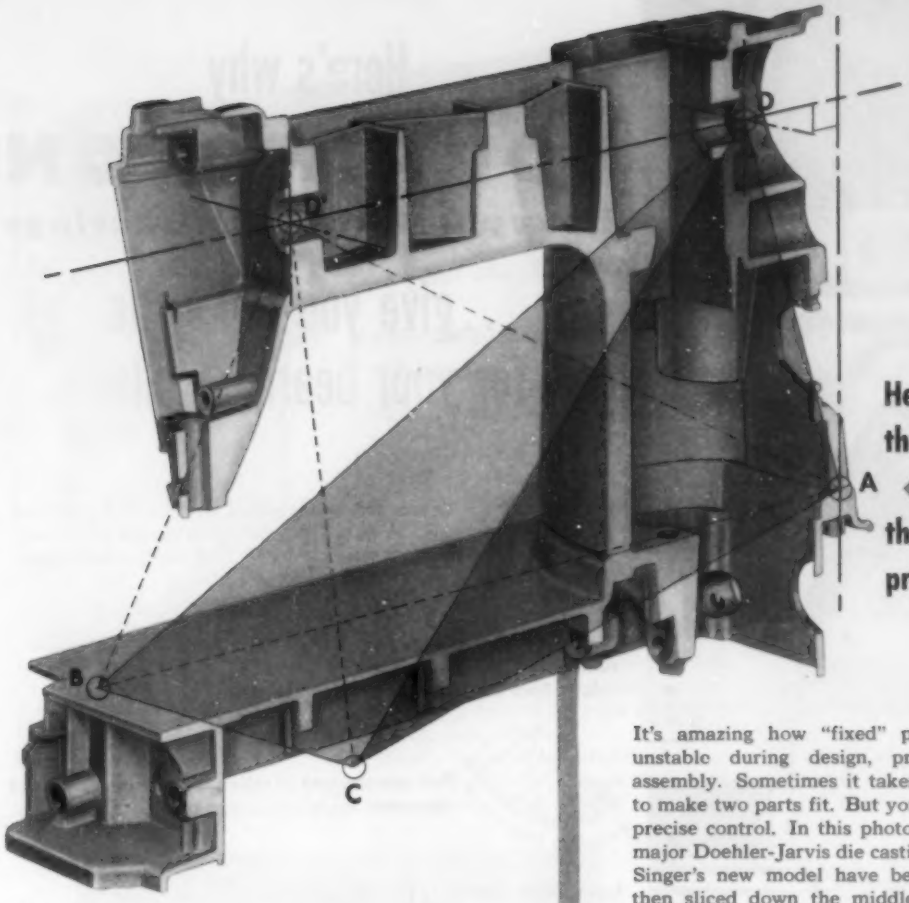
We call this precise new way of making things, "Tripod-Control Dimensioning."

It all started back in '35, when Singer asked Doehler-Jarvis to help pioneer the first die cast aluminum sewing machine components.

To meet the rigid precision requirements, Doehler-Jarvis engineers devised what may have been the first ground and hardened tool-steel casting die ever used. It had its faults, but it did give them machine-tool accuracy. And they discovered the germ of the "Tripod-Control" idea.

What had been discovered was the way to extend a familiar two-dimensional control . . . "baseline dimensioning" . . . to the control of precision in three dimensions. With it they could control precision of and *between* two (or more) die castings of an assembly. They selected a point of vantage common to the parts. Through the point was established a "tripod" of reference from which all critical angles and dimensions could be controlled. Errors vanished. Precision went up . . . assembly troubles down.

Then the idea spread in both the Doehler-Jarvis and the Singer plants. It was used to make multiple gauging jigs . . . used as the basis



Here are the "tripods" that control precision

It's amazing how "fixed" points become unstable during design, production and assembly. Sometimes it takes manhandling to make two parts fit. But you *can* establish precise control. In this photograph the two major Doehler-Jarvis die castings that frame Singer's new model have been assembled, then sliced down the middle to show the "Tripod-control" method. An imaginary plane of reference, ABC, controls the bed casting dimensions. It passes through point A, a real point of vantage common to both parts. With this plane as a base, imaginary "tripods" are erected to "fix" the plane ADD' and control arm-casting dimensions. The same planes control precision measurements in all following operations.

into parts

finer than ever

for ganged machining . . . used in finishing . . . used in assembly.

By the time the "Slant Needle" model came along, "Tripod-Control Dimensioning" had grown to a full-fledged design and production technique . . . based on die castings . . . used even in the first rough sketches of the new product . . . used in the planning stages . . . used throughout tooling and production.

Today? Well . . . you never saw production flow more smoothly when complex precision parts are made by one company, finished and assembled by another.

In its half century of die casting, Doehler-Jarvis has helped many producers, large and small, find the best way to take full advantage of die casting techniques . . . among them some of the best known makers of automotive, electrical, communication, household, office and other types of equipment.

When they come to Doehler-Jarvis, they know that Doehler-Jarvis can supply both the resources and the resourcefulness they need.

So next time you have a new product on the boards . . . call Doehler-Jarvis in on the design and production engineering. We may be able to give you just the solid kind of help you're looking for.

Doehler-Jarvis Division

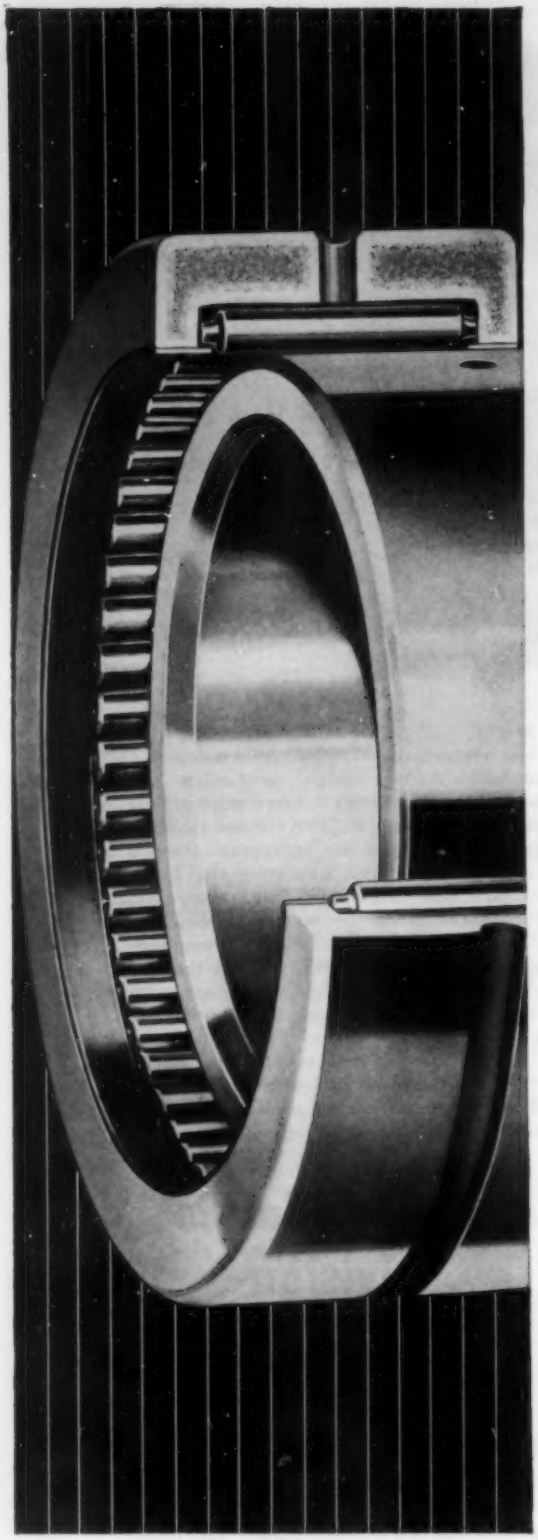
of

National Lead Company

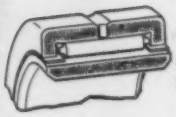
General Offices: Toledo 1, Ohio

DOEHLER-JARVIS

*Reg. U.S. Pat. Off.

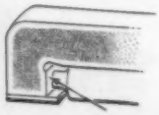


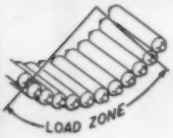
Here's why
TORRINGTON
Heavy Duty Needle Bearings
...give you top value for your bearing dollar



Carburizing grade nickel steel for both inner race and one-piece outer race gives harder, more wear-resistant surfaces, tougher, more shock-resistant cores.

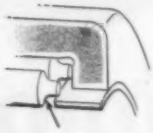
Accurately ground raceway and side flange surfaces are sturdy and eliminate drag at roller contact, keep rollers in true path. No cage required.

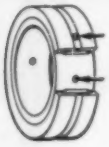




Full complement of rollers of precision controlled diameters assures maximum load carrying capacity.

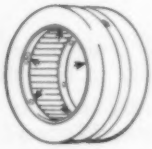
Large roller diameters provide maximum trunnions with large fillets for increased strength—capacity—wear-resistance.





Lubrication groove in outer race, oil holes in both inner and outer races permit easy, effective lubrication to the channel and rolling elements.

Stainless steel retaining bands spot welded into position for positive roller retention. Resist entry of foreign matter. Fragile lips eliminated.



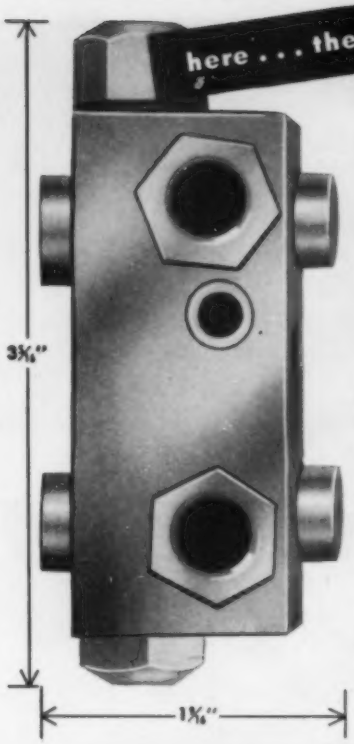
Unit outer race assembly for operation on hardened, ground shaft allows easy installation. Torrington Heavy Duty Needle Bearings are available from stock in a complete range of sizes. Try them—compare them for VALUE!

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

TORRINGTON HEAVY DUTY NEEDLE BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

here . . . the "lubrication fitting" that never forgets!



ALEMITE Accumeter®

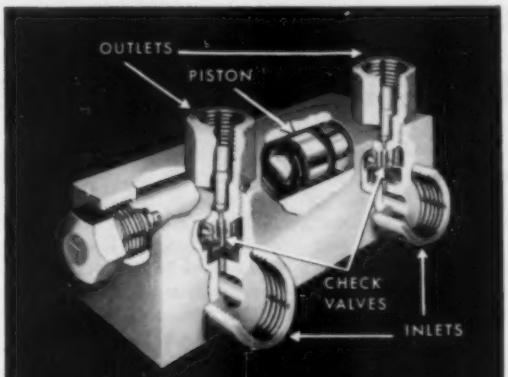
provides automatic, fool-proof lubrication for the heaviest, biggest machines, operating under the toughest conditions . . . indoors or outdoors!

Picture a machine under the toughest job conditions you can imagine. Where bearings operate under the *worst* conditions—in dust, rain, fumes, grit—even completely immersed. Here, ordinary manual lubrication methods would be costly—man-hours would be wasted and production time lost while the machine was shut down for lubrication.

If you were designing this machine, what method could you specify to make sure *every* bearing would always be properly lubricated?

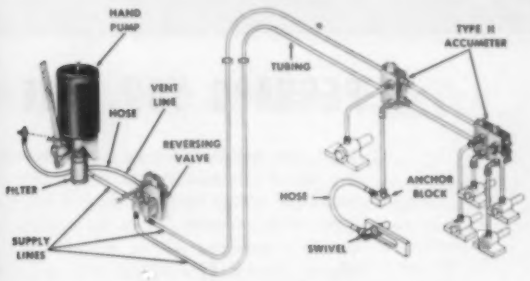
Here's the answer—Alemite Accumeter, the valve that is far more dependable than any man. This simple, completely sealed system delivers an *exact* amount of lubricant where it is needed at *exactly* the right time—*while the machine is in operation!* Time, maintenance and production costs drop—while output soars! No wonder more than 95% of all major plants buying machine tools specify centralized lubrication!

And Alemite Accumeter Systems are easy to design into any machine—and there is a system ready to solve any machine lubrication problem. Find out about these automatic systems now. See for yourself the tremendous savings and efficiency they allow you to offer when you specify automatic Accumeter.



Type II Accumeter Valves

Each serves two bearings. In four sizes delivering from .010 to .500 cubic inch of lubricant. Adjustable. Fully hydraulic—no springs. Completely sealed system serves up to 600 bearings. Manual or power operation.



offers all these advantages!

- Eliminates shut-down time for lubrication. Adds productive time to machine output.
- Seals completely against dirt, grit, fumes, water all the way from "barrel to bearing."
- Prevents bearing troubles due to neglect or wrong lubricant.
- Services all bearings—including those inaccessible or dangerous—in one operation.
- Avoids work spoilage and bearing repairs due to over-lubrication.

factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles. Equal to 122 years of twice-a-day service!

Free—*Alemite Accumeter Catalogue*

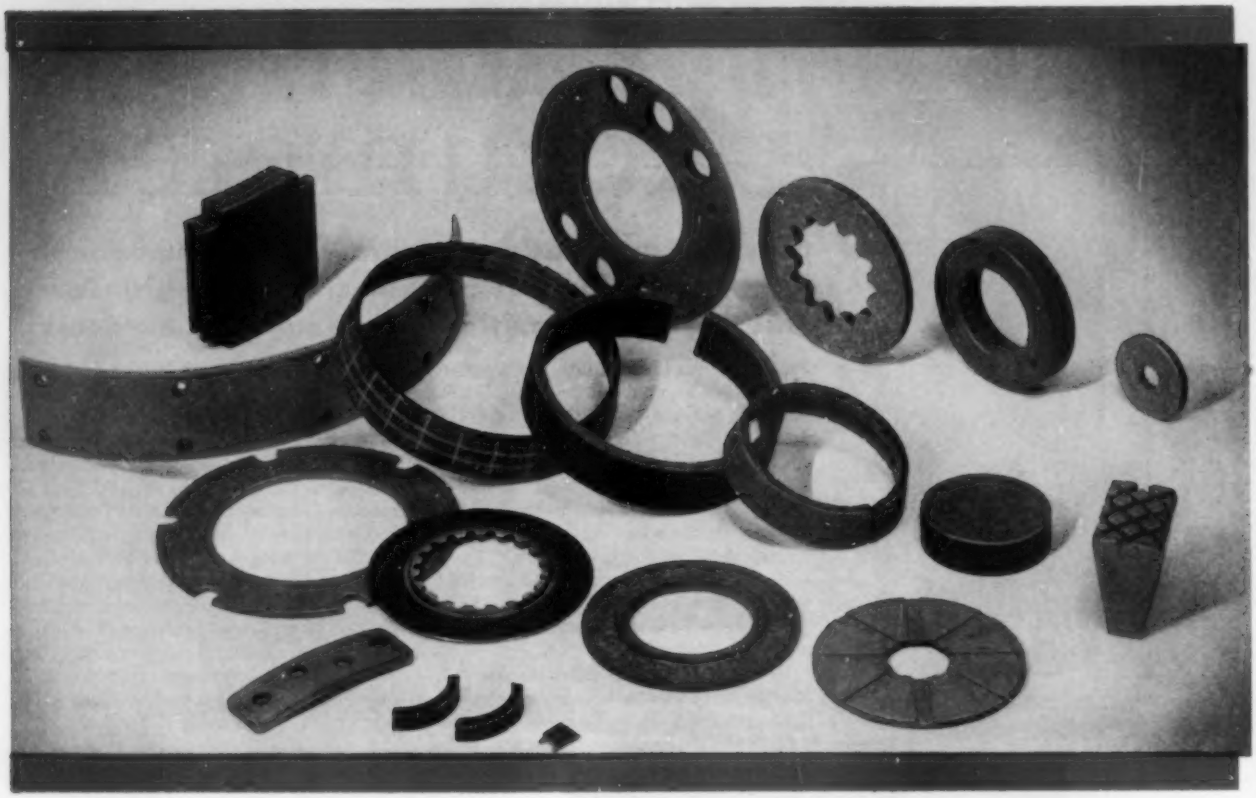
ALEMITE, Dept. T-24
1850 Diversey Parkway, Chicago 14, Illinois

Name .....
Company .....
Address .....
City ..... State .....

ALEMITE
REG. U. S. PAT. OFF.

A PRODUCT OF SW STEWART WARNER

CALL ON R/M ENGINEERING SERVICE



PERHAPS YOU HAVE A FRICTION MATERIAL PROBLEM

If so, you will be interested to know that R/M is the world's largest maker of friction materials; that R/M makes friction material products for all types of equipment—from the lightest household or office appliance to the biggest train, truck or tractor; that R/M works in both the asbestos and metal fields—woven and molded asbestos, semi-metallic materials, and sintered metal are all in the picture.

Many of Raybestos-Manhattan's friction material products are the direct result of cooperation between design engineers and R/M research. One outstanding example of this teamwork is R/M's work with automotive engineers. It has resulted in there being an R/M part on every model of every automatic transmission made.

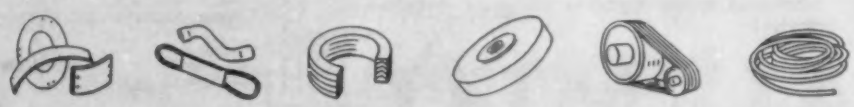
If you are designing or making a product which requires friction materials, you will find it helpful to call on R/M's specialized Friction Materials Engineering Service. Whatever your problems, whatever your requirements, R/M's experience, skills and facilities will be advantageous to you. For detailed information about R/M brake linings, clutch facings and special shapes of friction materials, send for booklet today.

For booklet shown, or other data, write, phone or wire:

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS



Brake Blocks, Linings and Clutch Facings | Fan Belts and Radiator Hose | Mechanical Packings and Gaskets | Abrasive and Diamond Wheels | Industrial Drive Belts | Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS

PACKINGS, GASKETS, Asbestos Textiles and Teflon* products

For specialized packing engineering service call on Raybestos-Manhattan. R/M makes a complete line of packings and gasket sheets for use against air, gas, water, steam, oil, solvents, foods and hydraulic fluids. It also makes an unusual number of asbestos textiles and a wide variety of Teflon products. The many years' experience R/M has had in these fields can be put to work for you in an instant. Just say the word. Send for booklet on packings, gaskets, and Teflon products.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

For booklet shown, or other data, write, phone or wire:

PACKING DIVISION OR ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

R/M SUPER-POWER V-BELTS

With R/M Super-Power V-Belts you obtain up to 40% greater horsepower capacity over the same number of regular V-belts. You can save space as fewer belts are required. In addition, there is virtually no stretch and practically no matching problem. Made with new high strength synthetic cords. Straight sidewalls provide more grip, less slip, longer life. R/M Super-Power V-Belts are also oil-proof, non-spark, and heat-resistant. Bulletin 6628 contains details. Of course, Condor V-Belts continue to be the standard for regular service.

For booklet shown, or other data, write, phone or wire:

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Gregory 3-2000

RAYBESTOS-MANHATTAN, INC.

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Teflon Tape, Packings, Sheets, Rods, Tubes

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we sell ALLIS-CHALMERS CONTROL

we give ENGINEERING HELP

Contact Your Nearby Allis-Chalmers Representative

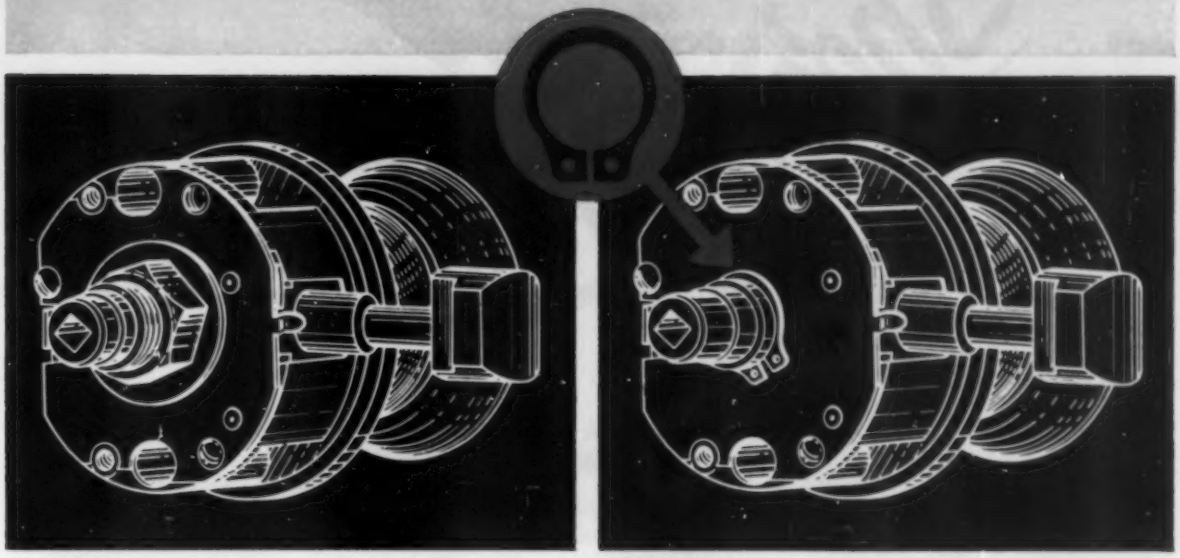
The time to call on your Allis-Chalmers field engineer is when your equipment design is in the drafting board stage. Your A-C representative is an application specialist — ready and able to work with your staff to determine your control needs. His suggestions and analyses are backed by Allis-Chalmers engineering departments . . . by the experience gained in solving thousands of control problems . . . by complete research and testing facilities.

Pictured here are just a few of the many Allis-Chalmers control devices . . . standard, modified standard, and especially designed equipment. Each is recommended and applied with personal, expert attention to your particular problem . . . to assure top operating efficiency of your equipment. Get all the facts on Allis-Chalmers control plus application assistance. Write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4053

Regulex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

Waldes Truarc Ring Replaces Nut and Washer ...Cuts Costs $5.28 Per M...Speeds Assembly by 50%



OLD WAY. Main shaft required costly threading. Assembly was slowed by the double application of washer and nut and time-consuming tightening operation.

TRUARC WAY. Truarc Retaining Ring snaps quickly and simply over shaft. Lock assembly is secured in one fast operation. Virtually all play is eliminated from lock.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS

OLD WAY

Cost of Nut	$10.00	*per thousand*
Cost of Washer	3.80	" "
Labor for Threading	2.00	" "
Assembly	3.00	" "
TOTAL	$18.80	

TRUARC WAY

Cost of Truarc Ring and Grooving Operation	$11.52	*per thousand*
Assembly	2.00	" "
TOTAL	$13.52	

J. Chesler and Sons, Inc., Brooklyn, N.Y., manufacturers of the pre-assembled "Reddi-Mount" cylindrical lockset, uses a single Waldes Truarc Retaining Ring instead of an old fashioned nut and washer to secure the entire assembly of their lock. This new, improved fastening method enables Chesler to eliminate costly threading ... save money on material ... speed assembly time by 50% and produce an improved, more durable product.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered ... quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

PN026

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool

SEND FOR NEW CATALOG

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,341; 2,439,789; 2,441,846; 2,455,165; 2,470,941; 2,483,380; 2,483,383; 2,487,902; 2,487,903; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name.....

Title.....

Company.....

Business Address.....

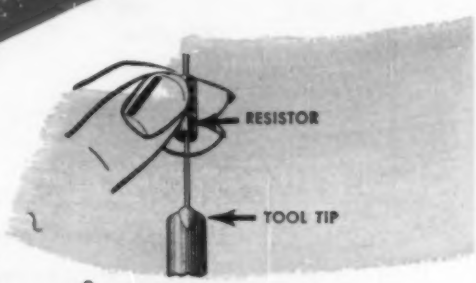
City..... *Zone*..... *State*.....

She's a pistol-packin'

. . . AND A ROOTIN' TOOTIN' BOOSTER IN THE *Wire-Wrap* BRIGADE!

The electrical connections she used to wind-and-solder, she can make now in half the time with a Keller Wire-Wrap Gun. Stronger, too . . . stronger mechanically and stronger electrically without the use of solder.

Now there is no hot iron to handle, no sizzling flux, no solder drippings to splatter. And since wiring costs have dropped way down, her boss is a booster, too!

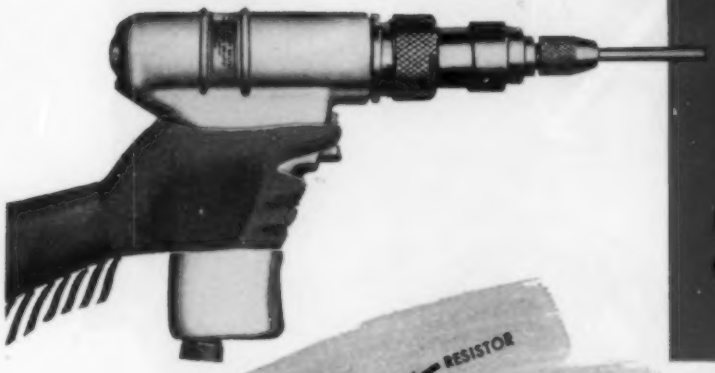


1 INSERT WIRE

Solderless Wire-Wrap connections avoid failures caused by solder shorts, dropped clippings, and heat damage to delicate parts.

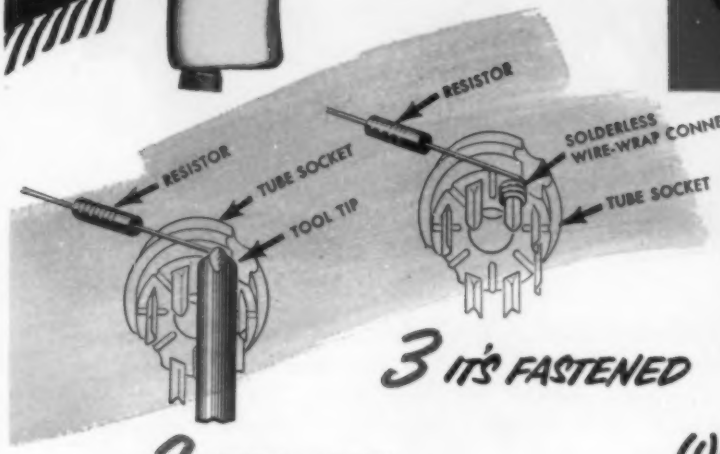
Wire-Wrap Division

mamma now!



KELLER
*Wire-Wrap**
TOOLS
MAKE SOLDERLESS CONNECTIONS IN HALF THE TIME

* Trademark



3 IT'S FASTENED

2 ZIP... AND

SEND FOR BULLETIN 11
for complete information about these new tools

Wire-Wrap Tools
are now available from Keller
—the original manufacturer

Power Tools Engineered to Industry

KELLER TOOL CO.
GRAND HAVEN, MICH.

Heat transfer elements of *Mayari R* withstand extreme temperature swings

Hot flue gas passes through one side of the Ljungstrom preheater, and a stream of cold air passes through the other side. Heating elements, contained in a rotor, are passed alternately through the flue gas and incoming air stream. The use of Mayari R in the cold-end heating elements assures protection against corrosion.

Several times a minute each element in the rotor of the Ljungstrom air preheater comes in contact with hot flue gas at temperatures as high as 700 deg, followed by relatively cold air at temperatures as low as 70 deg. These extreme changes in temperature obviously have a tendency to corrode the heat-transfer elements.

The use of corrosion-resistant Mayari R in the cold-end heating elements, which are more susceptible to corrosion, permits their operation at low gas-exit temperatures without undue cost of replacement due to corrosion. Result: Continuous operation of the preheaters can be maintained with high overall efficiency.

Tests indicate that Mayari R has from 5 to 6 times the atmospheric corrosion-resistance of plain carbon steel, and from 2 to 4 times that of copper-bearing steel. As for workability, Mayari R can be formed, fabricated and welded by the usual methods, using ordinary shop equipment.

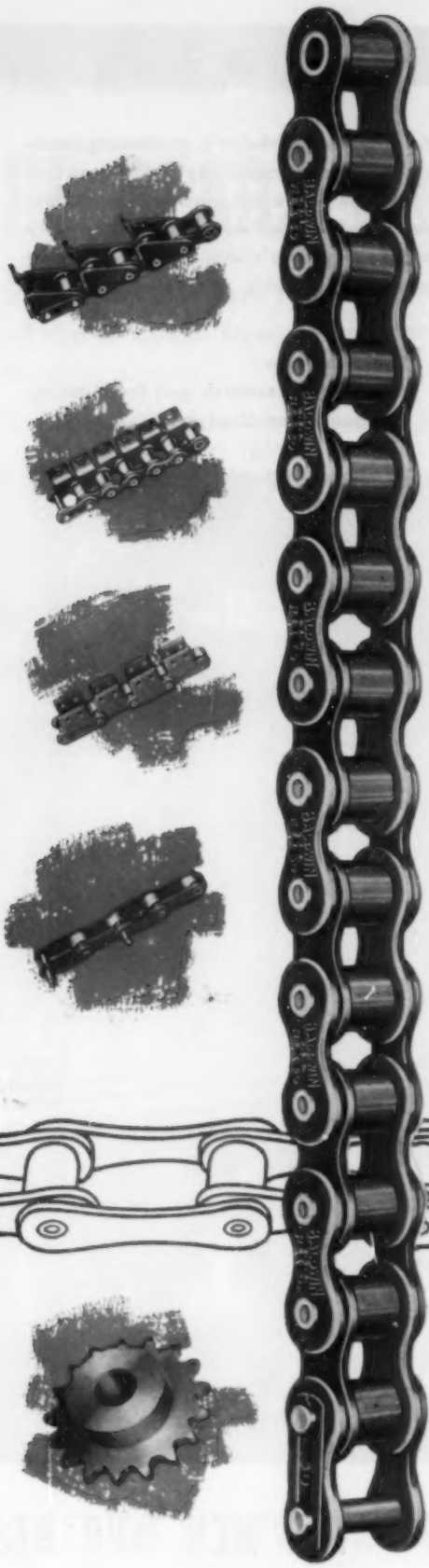
Other problems involving industrial heat have been solved effectively by using Mayari R. For more information about its properties and recommended uses, write for a copy of Catalog 259.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Mayari R *makes it lighter... stronger... longer lasting*



SAVE handling costs

Here's a good way to solve the problem of moving materials through the machines you design... the complete line of Rex Roller Chains, Sprockets and standard and special Attachments. Whether it's moving bread through a wrapping machine... milk cartons through the bottling machines... or metal parts through a plating machine, there is a Rex Roller Chain and Attachment that can do it more efficiently... at lower costs.
Your Chain Belt District Sales Engineer will be happy to assist you with your selections or to recommend the design of an attachment to suit your individual needs. Call him or mail the coupon today.

CHAIN BELT COMPANY

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☐ Please send me literature on Conveying with Roller Chains.
☐ Have Chain Belt man call.

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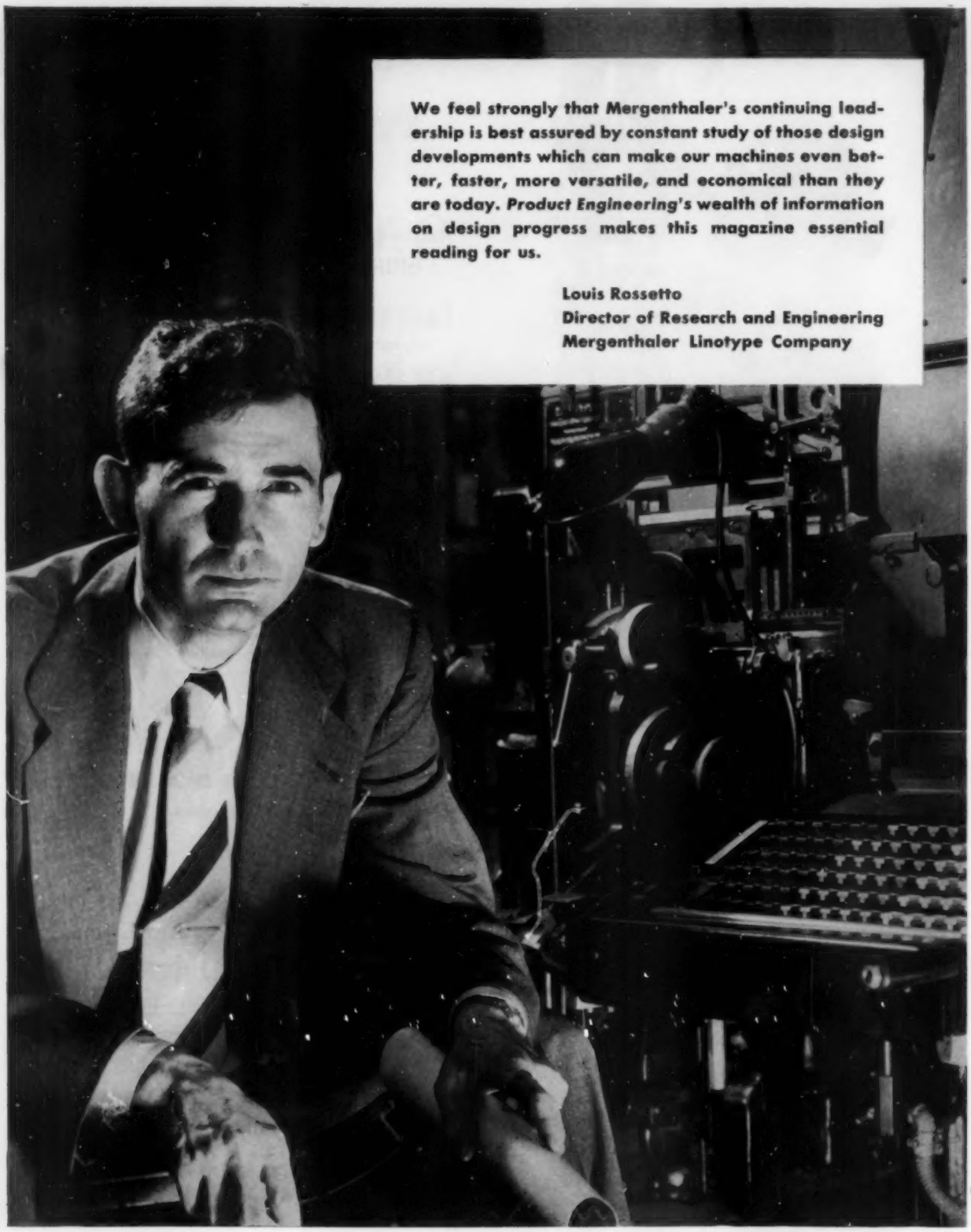

We feel strongly that Mergenthaler's continuing leadership is best assured by constant study of those design developments which can make our machines even better, faster, more versatile, and economical than they are today. *Product Engineering*'s wealth of information on design progress makes this magazine essential reading for us.

Louis Rossetto
Director of Research and Engineering
Mergenthaler Linotype Company

THE MEN WHO DESIGN

He leads design at Mergenthaler Linotype

HE READS PRODUCT ENGINEERING

You advertise here to reach the concentrated heart of the Original Equipment Market's $30-billion buying power

There was a time, not many years ago, when the total national budget was less than $30-billion. Today, however, that much annual buying power is concentrated in the Design-Engineering Headquarters where industry's new machinery, equipment, and appliances are created.

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The sales-wise facts about *Product Engineering* have never been more important to know about than now. Your *Product Engineering* representative has all of them. Call him today, or write directly to us at New York 36.

**As of November, 1953. June, 1953 ABC net-paid was 22,968*

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A McGraw-Hill Publication
McGraw-Hill Building, New York 36

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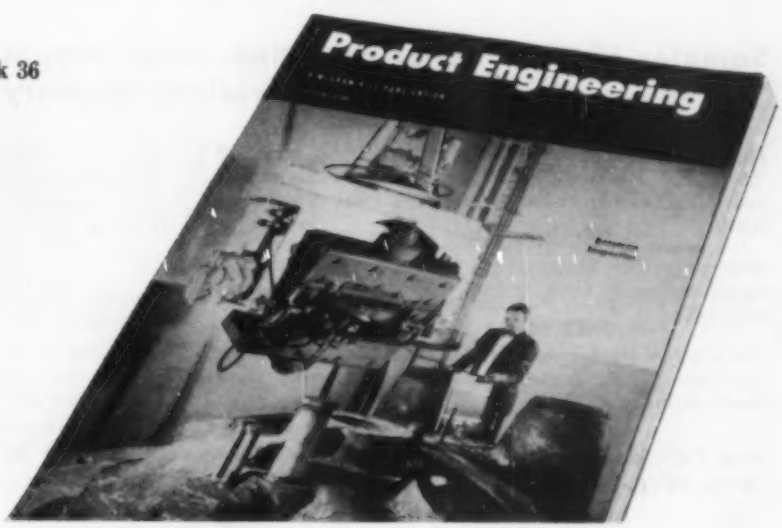
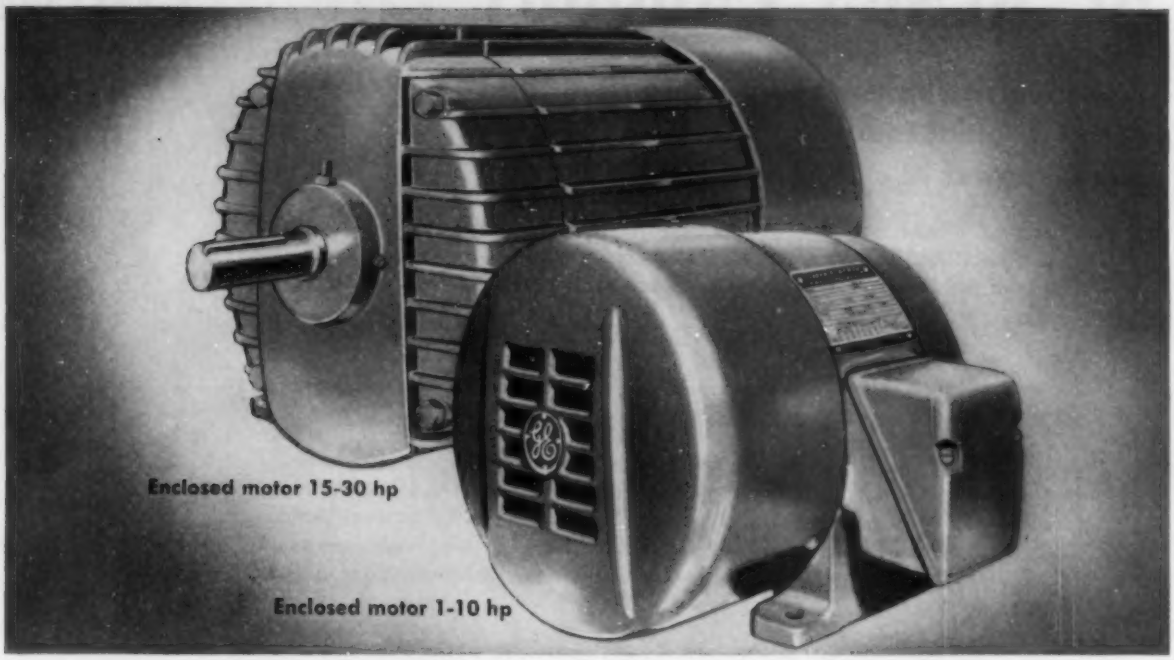


AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

Designer's



ENCLOSED TRI/CLAD '55' MOTORS offer better protection from moisture, dirt, corrosion.

Modernize your machinery

Samples of G.E.'s better-protected, more compact motors available now: 182 and 184 frames available January 1 in quantity.

Now you can specify General Electric's new Tri/Clad '55' motor. It's designed to better all previous standards of motor performance. Here are some of the new features:

TOUGHER INSULATION

New polyester film slot and phase insulation is 8 times stronger than ordinary electrical insulation materials.

HIGHER FULL-LOAD SPEEDS

Tests prove that a new Tri/Clad '55' attains greater full-load speed, horsepower for horsepower, than most ordinary motors.

SONANT OPERATION

New Tri/Clad '55' is "sound engineered" to reduce "siren effect," bearing rattle, and wind resistance.

LIGHTER WEIGHT

Elimination of waste space between stator and frame helps make the new Tri/Clad '55' lighter . . . up to 33% weight reduction in some ratings.

SMALLER SIZE

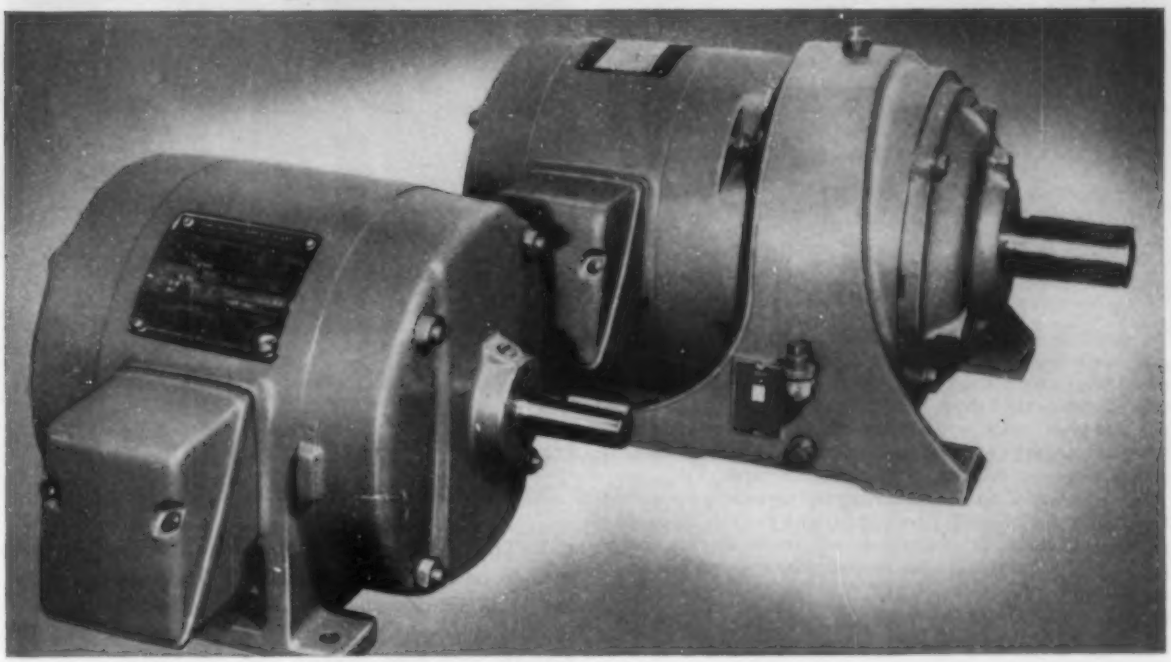
Smaller over-all motor size (up to 40% in some ratings) saves you money on shipping, handling, storing, installing.

To order your new motors, contact your nearest G-E Apparatus Sales Office or authorized motor agent. Or you can send in the coupon at right for three new full-colored bulletins on the complete Tri/Clad '55' motor line.

GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS



DRIPPROOF AND GEAR-MOTORS, completely new inside and out, assure longer motor service life.

with new TRI 55 CLAD motors

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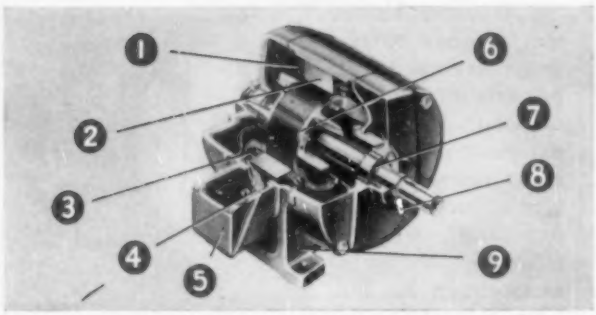


NEW MOTOR DESIGN INCLUDES: (1) polyester film slot, phase insulation; (2) press fitted stator punchings; (3) water-shedding stator windings; (4) perma-numbered leads; (5) easy-access conduit box; (6) solid-cast rotor windings; (7) advanced bearing system; (8) protected end shields; (9) cast-iron construction.

General Electric Company
Apparatus Sales Division, Sec. F668-108
Schenectady 5, N. Y.

Please send me the following bulletins:

√ for reference purposes
× for immediate project

- ☐ GEA-6012 Tri/Clad '55' Enclosed Motors
- ☐ GEA-6013 Tri/Clad '55' Dripproof Motors
- ☐ GEA-6027 Tri/Clad '55' Gear-Motors

CONSULT YOUR SWEETS PRODUCT DESIGN FILE. You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME_____

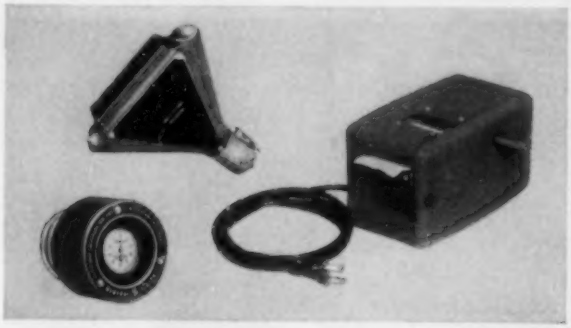
COMPANY_____

STREET_____

CITY_____ STATE_____

TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

G-E VIBRATION MEASURING EQUIPMENT CAN CHECK YOUR MACHINERY DAMAGE

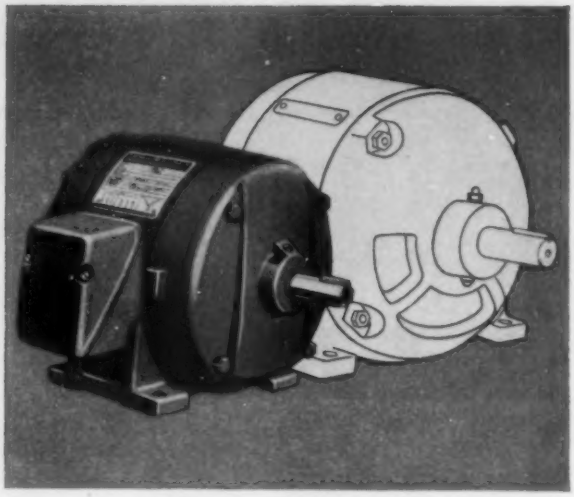


To guard against excessive vibrations that cause damage to machinery and buildings, use General Electric's vibration measuring instruments. A variety of types and forms are offered such as the light-beam type unit (top, left); the general-use dial-type indicator (bottom, left); and the recording vibrometer (right). All are accurate, reliable instruments that can save on your original equipment investment.

For information on all G-E testing and measuring equipment for laboratory and production use, ask for the new measuring equipment catalog. It's a complete and concise 80-page master reference, covering everything from simple current indicators to automatic oscillographs. Brief descriptions, applications, specifications and prices for each product enable you to select quickly and easily. Check GEC-853.

NEW G-E CALROD* HEATER CATALOG HELPS SOLVE HEATING PROBLEMS

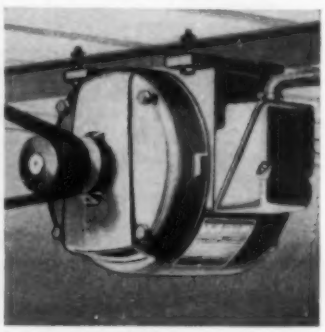
If a machine or process needs a "spot" or "zone" of heat here and there, why become involved in complicated piping and expensive equipment? Simply specify the right type of General Electric Calrod heater for clean, convenient, easily controlled heat. Reliable, accurate and compact, these heaters are quickly installed and require practically no maintenance. The broad range includes immersion, strip, cartridge, tubular, fin, and unit heaters. This 1954 comprehensive 60-page booklet gives you complete data on each type, including applications, features, dimensions and prices. For information on heat for any machine you build that needs heat, check Bulletin GEC-1005.



Lighter, smaller TRI 55 CLAD motors now available in quantity

G-E Tri-Clad '55' induction motors can be delivered now in new NEMA 182 and 184 frame sizes. You'll find this brand new line of lighter-weight, smaller motors can help you design new and more saleable features into your product; can free you from former design limitations. Smaller size saves space on driven machines. Lighter weight—up to 30% weight reduction in some ratings—saves you money on shipping, handling, storing, and installing. ***Important! Size and weight reduction has been made without sacrificing the power rating and service factor of previous models.***

The new Tri-Clad '55' is better looking and designed to give longer service life. It has stronger insulating material, 60% more external protection, many new safeguards against moisture, and dozens of improvements in the art of motor design. See Bulletin GEA-6013 for more information.



END SHIELDS

Can be rotated to any of four positions . . . makes them completely dripproof even when ceiling mounted.

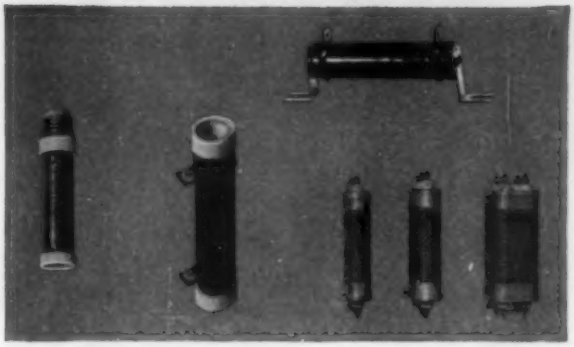
*Reg. trade mark of General Electric Company.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS

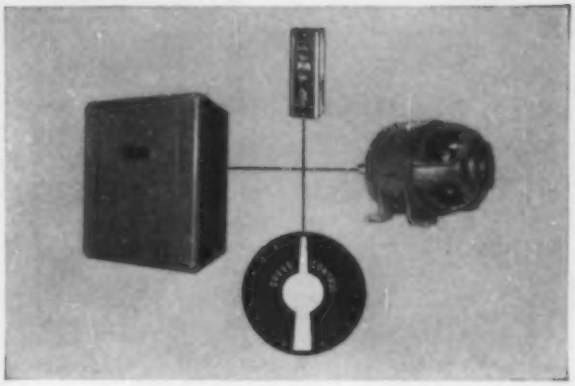
SIMPLE "BLUE STICK" RESISTORS OFFER WIDE DESIGN APPLICATION



These General Electric resistors are among the simplest control products manufactured. Standard ±5% resistance tolerance makes them extremely adaptable for innumerable design applications. Built for long life, even in moist atmospheres, each unit is vitreous enamel coated (giving a blue-like appearance), which makes it mechanically airtight, moisture-proof and extremely durable. Consistent resistance characteristic is maintained by nichrome wire wound around the ceramic cylinder. For full story, see Bulletin GEC-817.

G-E TIME SWITCH CATALOG SIMPLIFIES DESIGN OF ON-OFF CONTROL JOBS

Here's a handy reference manual to make the specification of those on-off control jobs easier. The fully illustrated 24-page manual contains selection and application information as well as descriptions of types and models available. It shows the convenience, economy and greater safety that G-E automatic time switch units can offer. Features, specifications, operating data and pricing information are also included. To see how G-E time switches are used, why they are used and how you can select and purchase the unit most suitable for your particular job, ask for Bulletin GEA-5965.



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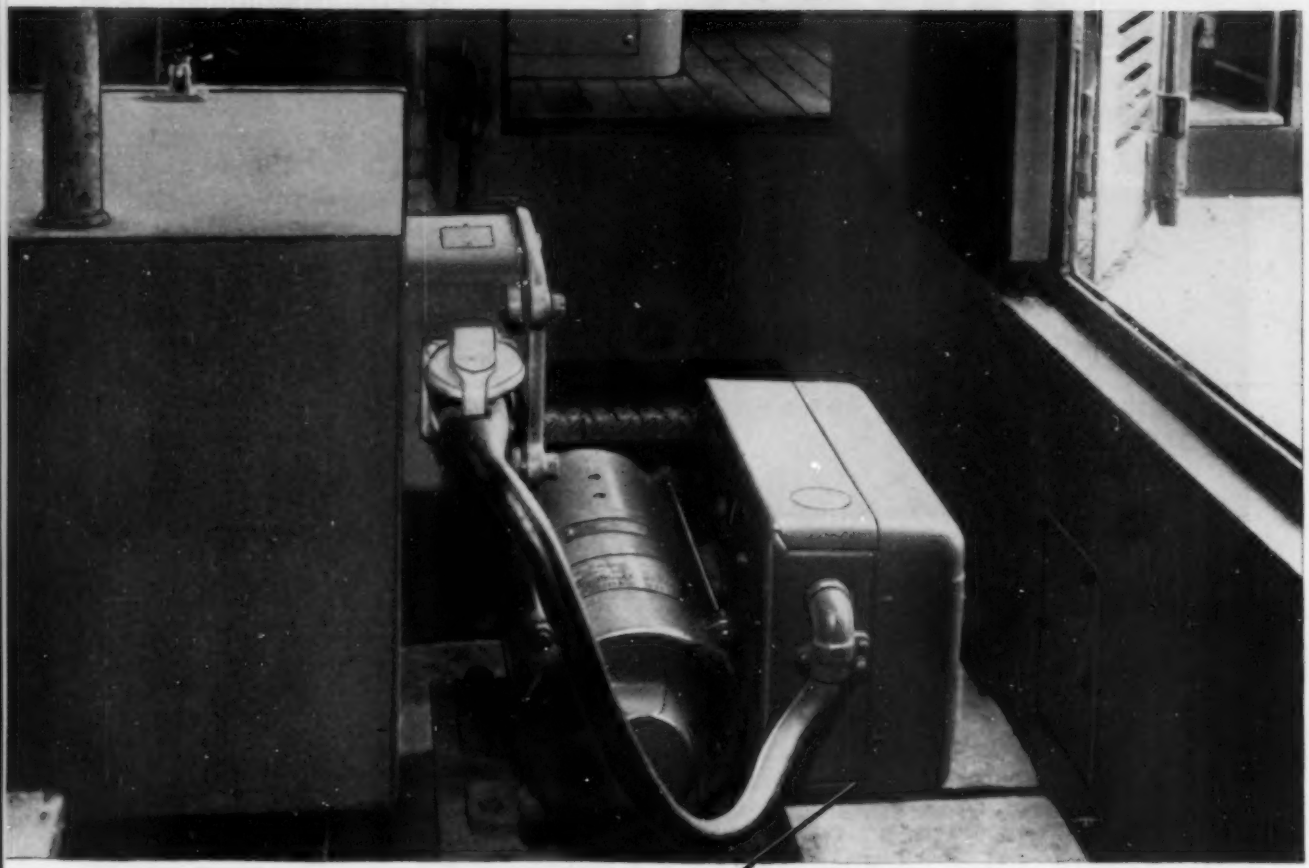
The Erie Railroad story shows why it pays to . . .

Get motor application

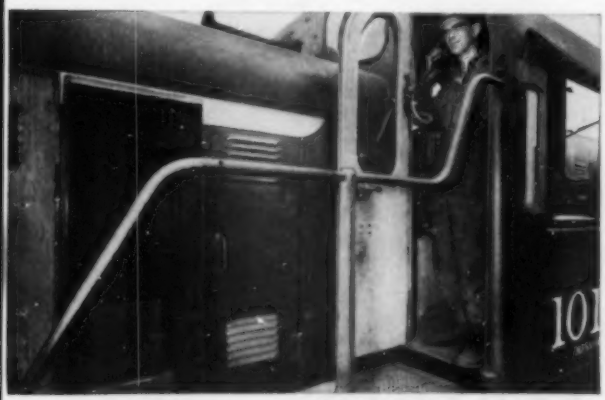


THE ERIE RAILROAD REQUIRED motor alternators to provide 115-volt, 60-cycle power for communication equipment between diesel-electric engines, cabooses, and control stations. The railroad had been using a 64-volt battery system. Illustrations (above) show the G-E designed motor alternator—chosen after competitive tests—and location in the engine. At right, is a brief story of how G-E engineers met the rigid specifications and solved the Erie Railroad's particular problem.

help from G-E Engineers

PROBLEM WAS PRESENTED to G-E sales engineer. Erie Railroad required maintenance-free operation for 3 month periods and a design that would make all servicing feasible except rewinding.

G-E ENGINEERS at the Specialty Component Motor Department in Fort Wayne, Indiana, designed a special open construction type of motor alternator to meet the railroad's precise specifications.



RUGGED TESTS were given this G-E motor alternator on a switcher in railroad's Marion, Ohio, yard. The design struck a happy medium as to design and service, now used on 75 passenger and yard diesels.

PROBLEMS of motor design and motor application are being solved daily at General Electric's Specialty Component Motor Department in Fort Wayne, Indiana. The accumulated engineering experience—unmatched anywhere—starts working for you when you bring your tough motor application problems to General Electric.

THE ERIE RAILROAD had the problem of providing a dependable power supply for their communications equipment mounted on diesel-electric passenger locomotives, switchers and cabooses. They established their needs as a motor-alternator set supplying 115-volt, 60-cycle current. Close voltage control was necessary to insure satisfactory radio tube operation.

WITH THESE REQUIREMENTS in mind, General Electric designed a 2-unit 2-bearing motor alternator which proved the merit and effectiveness of G-E application help in rugged competitive tests.

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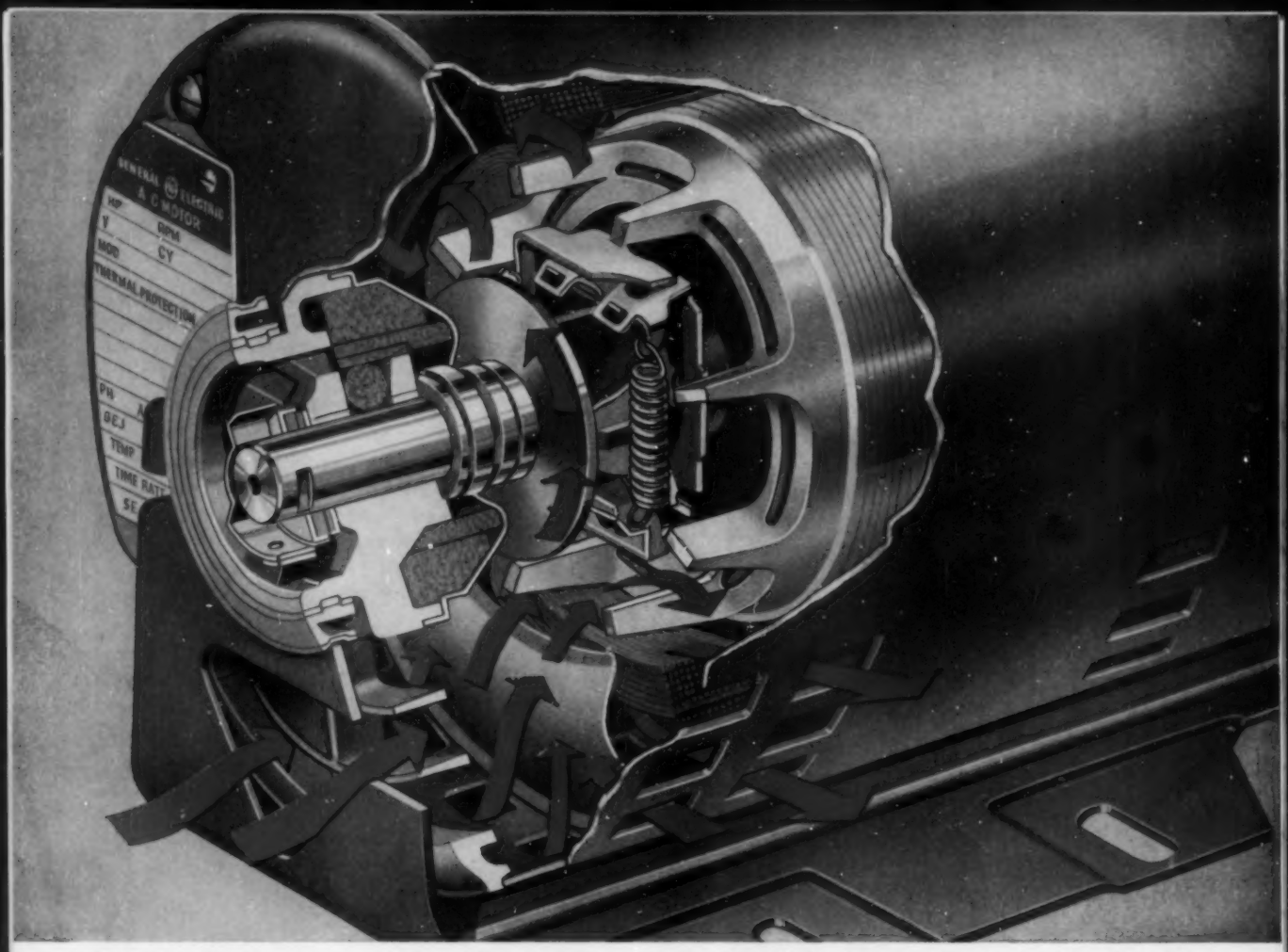
APPLICATION HELP provided by G-E engineers in solving the Erie Railroad's problem typifies the many cases where design engineers have found it pays to take motor application problems to G.E.



VENTILATION SYSTEM on new open drip-proof fhp motor pulls air in through end shield and first row of shell louvers. Baffle and fan uniformly direct the air over the windings and end rings where it absorbs heat . . . and exhausts it through the inside row of louvers. On the shaft end of the motor, air enters through the end-shield ventilating openings . . . absorbs the heat and exhausts it through the stator ventilating louvers. This controlled air flow permits more compact motor design.

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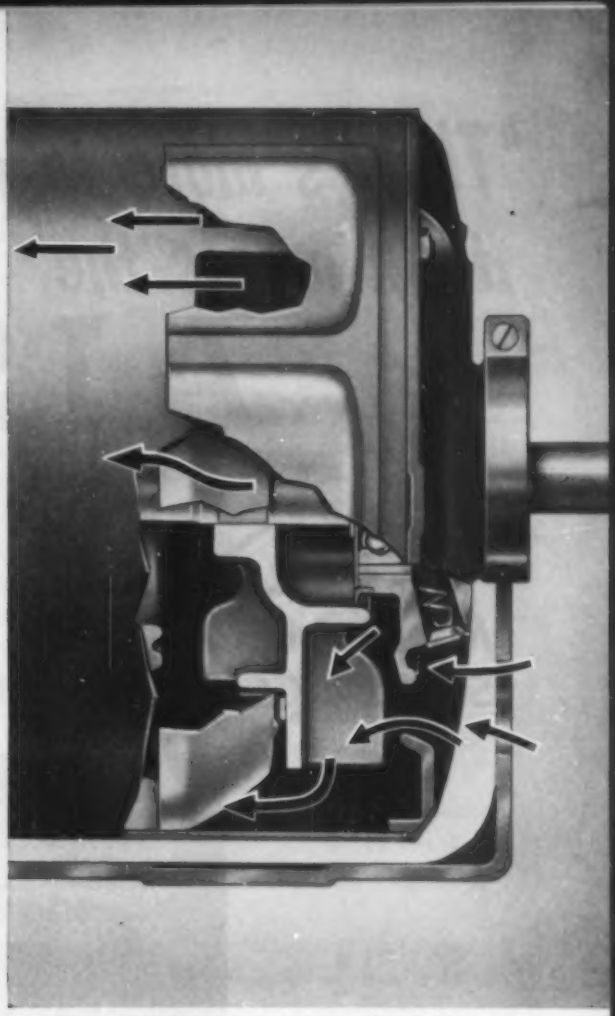
ELECTRICAL-MECHANICAL DESIGN applies new materials and techniques, providing full-rated power in smaller motor size. (1) Baffle channels air, helps prevent hot pockets. (2) Fan blades, cast integrally with the aluminum rotor windings, conduct heat from rotor for cooling.



TOTALLY ENCLOSED fan-cooled fhp motors now feature both external and internal fans within stator shell. Air enters through open end shield, passes by dust-tight motor cover, and out special louvers which guide cooling blast along stator shell.

make G-E fhp motors smaller

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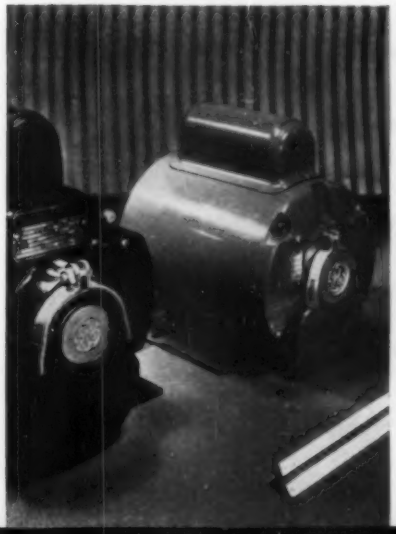

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Perspectives ~ DESIGN AND DEVELOPMENT

PATENT LEGISLATION

Facing a session jammed with controversial issues, returning Congressmen also have to wrestle with many minor irritations, not the least of which is change in existing patent laws and regulations.

To House and Senate leaders such issues as budgets, taxes, labor laws *(Product Engineering,* January 1954, p. 123), social security changes, tariffs and government reorganization rate top priority. Both Republicans and Democrats hate to open such a complicated subject as patent legislation in an election year, but there is considerable pressure on the lawmakers to remedy the gradual erosion that is eating away patent protection. A good share of the losses can be traced to "interpretations" made by various government agencies and bureaus. Congress is being asked to replace these opinions with concrete legislation.

Proposed laws cover a variety of interests: capital gains treatment of patent royalties, royalty adjustment, patent extension, invention award boards and fee boosts.

PATENT REVENUE

One of the hottest issues concerns how patent revenue is to be treated for income tax purposes. The Bureau of Internal Revenue has ruled that such monies—even when the patentee transfers all rights to a patent and receives indeterminate amounts from year to year based on a percentage of selling price—are "ordinary income." But tax courts consider such income as "capital gains." Patent groups want a law that clearly defines this income as capital gains.

Federal tax procedures are in for an overhaul in 1954. Because there's a wide difference of opinion between the House Ways and Means Committee and the White House, it is difficult to evaluate the chances of any bill defining patent revenue as capital gains.

Another ticklish tax proposal is the "depletion allowance" idea urged by various patent groups. If this were enacted, inventors would be permitted to claim exemption for a portion of patent income—33⅓ percent of gross income is a figure commonly suggested—because a patent is valid for only 17 years. Precedent for such action is the exemption already granted to operators of petroleum wells and mineral deposits because of resource exhaustion. However, such legislation has little chance for passage during the current session.

ROYALTY ADJUSTMENT

Royalty adjustment has been a sore spot with patent groups ever since the practice started back in 1942. At that time, Congress passed an act aimed at reducing payments of excess patent royalties on war production. Under

(Continued on page 125)

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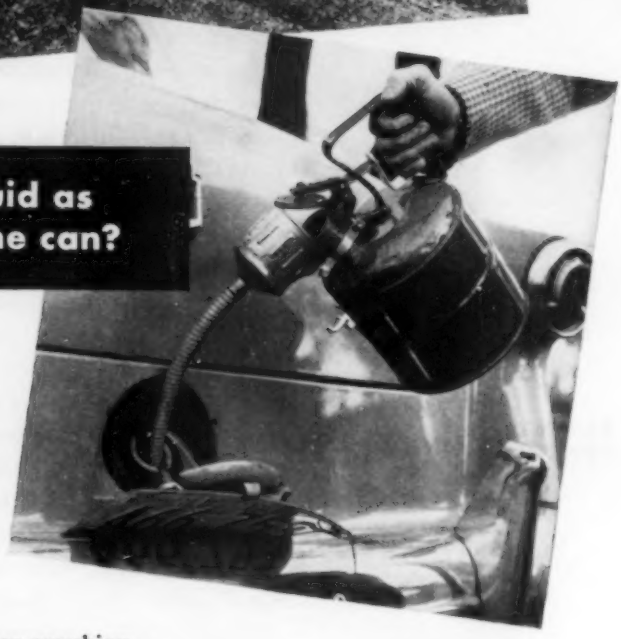

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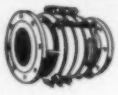

Expansion joints

Aircraft components

Metallic bellows

provisions of the measure, a defense service could readjust licenses, setting lower rates, if they considered that fees on an item were too high. Such legislation was in effect until June 1953.

Last year two new bills were introduced: HR 2560, which would have extended the act until six months after the Korean emergency, and HR 401, which would set up a permanent readjustment policy.

The House Patent Committee tabled both bills. Only the Department of Defense testified in favor of passage, while the American Patent Law Association, the National Association of Manufacturers and the National Patent Council bitterly opposed them. It is unlikely that there will be any action on such unpopular legislation during this congressional session.

EXTENSIONS

Other patent legislation that has scant chance of passage concerns extension of rights. There are at least eight bills in the hopper—HR 1228, 1301, 2309, 3534 and 4944, and S. 28, 523 and 787—which would grant extensions where a veteran was a partial owner or when patent exploitation was interfered with by war conditions.

INVENTION AWARDS

But one other class of patent legislation is assuming major importance. That's the establishment of an invention award board to make payments for patented or unpatented devices contributing to national defense. Currently there are three bills proposing this: HR 392 and 5889, and S 27. None of the three has much chance for passage this session—they are all too loosely drawn. As one patent lawyer put it: "Under these measures the government could award money for Civil War inventions."

In the future such legislation, properly written, might have a good chance for passage. The National Inventor's Council has supported the idea, while the American Patent Law Association and the National Patent Council, which has provided the most vocal opposition, are lined up against it.

Congress has asked various interested government agencies to study several types of invention reward systems and to comment on them. It's expected that hearings will be held later this year.

FEE INCREASES

Another piece of legislation that has a good chance for passage this year would increase the fees collected by the Patent Office. The Eisenhower administration has gone on record as favoring self-supporting departments, and the Patent Office needs a rate increase to make ends meet.

According to the Office, with a new fee schedule it would not only pay its way, but could double its classification work and reduce the application backlog by 10,000 per year. The suggested payments: filing, $40 (up from $30); five dollars for each claim over five (increased from one dollar for each claim over 20); final fee, $80 instead of the present $30; and two new fees—$100 for renewal five years after issuance, and $200 ten years later.

Although small inventors may protest the increases, other groups are wholeheartedly in favor of them. For instance, the American Patent Law Association, at its last meeting, voted agreement to the self-support principle.

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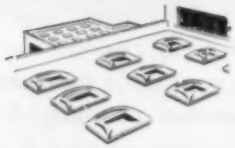

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Will the NSPE Take Over?

A recently issued report under the title "How to Attract and Hold Engineering Talent" was prepared at the Professional Engineering Conference Board for Industry, with the cooperation of the National Society of Professional Engineers. The report emphasized that 28 percent of the engineering graduates stated that they did not feel that their college training had prepared them adequately for an engineering career. The shopworn criticism that engineering colleges do not teach enough literature, writing and the humanities was also included.

What the report did not state is that the greatest single cause for the limited scope of engineering college curricula is the public high schools. Generally, the amount and quality of preparation that the public high schools give to their students who are preparing to study engineering has been declining steadily ever since the first World War.

So great has been the decline in public high school preparation for engineering education that today some of the technical universities require freshmen students to take "refresher courses" in high school mathematics. The student cannot start his college level mathematics until his second or third semester.

There can be no dispute over the premise that more engineers are needed and that they must be more fully trained. It is generally conceded that the engineering training must begin at the high school level. Engineering educators are well aware of the poor preparation given in most high schools for students who plan to study engineering. It is perhaps the most important problem facing the engineering profession and industry today.

The American Society of Engineering Education is fully cognizant of the situation and is doing practically all that it can. But that is pitifully little. The job it too big for a small organization like A.S.E.E. to get the results that are so sorely needed. The high schools themselves can do but little. Only the state legislatures can rectify the situation.

It cannot be expected that any sweeping changes in the high schools could possibly be brought about other than by the pressure of public opinion. The Engineers' Joint Council, which represents the major national engineering societies, presumably is aware of the situation and probably this is also true of the Engineering Committee for Professional Development. Whatever these organizations have done does not seem to have aroused public opinion appreciably.

The old line national societies, as stated repeatedly by their officers, avoid political entanglements and public questions of a non-technical character. Although the objectives of the A.S.M.E. have been defined to include the fostering of engineering education; whether or not that includes activities to improve preparation for an engineering course in our high schools is another question. Public schools and politics are closely linked.

In addition to the "old line" national engineering societies there is also the National Society of Professional Engineers. Apparently this organization is considerably more active in matters affecting engineers in their education, training and professional career. Will our old line national engineering societies relinquish to that organization the leadership that will bring about better engineering education and training and that will bring to the profession greater public recognition and esteem.

George F. Rodenhoff

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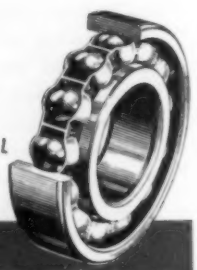

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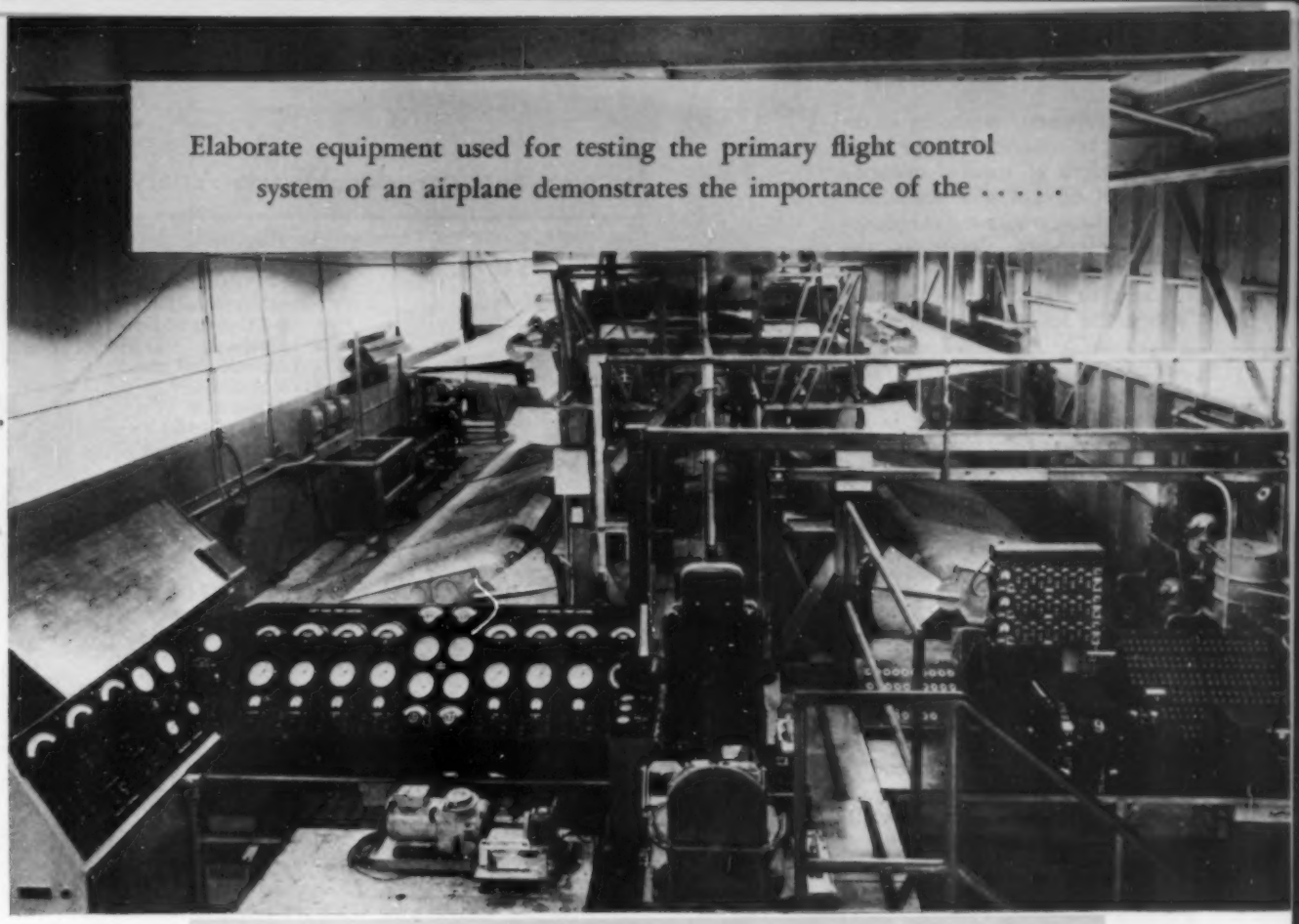


Elaborate equipment used for testing the primary flight control system of an airplane demonstrates the importance of the . . . . .

. . . Functional Aspects of Design

C. L. BATES
Assistant Director of Engineering
Ryan Aeronautical Company

So many factors must be considered in modern design that it is difficult to properly evaluate their relative importance. Proper functioning under various operating conditions, serviceability, producibility, appearance, cost and, safety are some of the more important items. →

THE FUNCTIONAL APPROACH to design can be considered as the systematic analysis of required operating conditions, effect of environment, mechanical characteristics and overall system requirements. Sometimes this includes a malfunction analysis.

The same design approach applies, whether the article being designed is a typewriter, an amphibious tank or an airspeed indicator for a high speed airplane. There are obvious differences in detail considerations, but in all three cases, a careful study of the functional items mentioned above is important in product development.

Each functional component can be considered a system—a transmission is a system of precision machined parts. In turn, every system can be treated as a component in a larger system—an airplane control system is part of the airplane which behaves as one big system, and the airplane itself is a component in an air defense or transport system. Good design must therefore include consideration of the functional relationships between a given system and other systems with which it must operate. This approach insures integration of the system to achieve complete compatibility.

Factors to Consider When Analyzing

I. OPERATING CONDITIONS

(1) Manual vs powered
(2) Manual vs automatic
(3) Normal, standby or emergency
(4) Continuous, intermittent or cyclic
(5) Short vs long life
(6) High vs low temperature
(7) Speeds required
(8) Load conditions
(9) Motions required

II. ENVIRONMENTAL CONDITIONS

(1) High temperature
  (a) Heat from outside sources
  (b) Heat generated by equipment
(2) Low temperature
(3) Abrasion
  (a) Grit
  (b) Sand and dust
  (c) Metallic particles
(4) Corrosion
  (a) Salt water
  (b) From handling
  (c) Contact with acids
(5) Fungus
(6) Altitude (low pressure)
(7) Vibration
(8) Acceleration
(9) Impact (shock)
(10) Thermal shock
(11) Moisture
  (a) Liquid
  (b) Ice

III. SYSTEM CHARACTERISTICS

(1) Mechanical
  (a) Response time
  (b) Backlash
  (c) Increment of control (sensitivity)
  (d) Position lag
  (e) Overshoot
  (f) Nominal travel
  (g) Efficiency
  (h) Friction
  (i) Lubrication requirements

Operational Functions

Generally, there are many operating conditions to be considered in a given design. Failure to have these conditions adequately described so that all designers working on a project can study their effects, will almost surely lead to unsatisfactory results; many design "bugs" are traceable to such failures.

Components can be operated manually or automatically. A valve in an aircraft fuel system may be a simple type with a handle turned by the pilot, or a part of an automatic sequencing system. The designer must carefully study the advantages and disadvantages of automaticity for such applications. Once the choice is made, this fact becomes a functional requirement to the equipment manufacturer.

Another important consideration is whether a unit is part of a normal system, a standby system, or an emergency system. Many emergency systems are designed for one-shot use without provision for resetting. A fire extinguishing system may have a simple rig to open the valve but little or nothing for closing it again; an airplane ejection seat is strictly an emergency unit. Other assemblies may be of a standby nature with permissible short life in the interest of saving weight and cost.

These illustrations point up the problem of duty cycle. Many systems require considerable power for short periods of time, while average power requirements are comparatively low. This is true of many power control systems for which the duty cycle must be known so that the lightest possible system can be designed.

A duty cycle may be continuous, intermittent, cyclic, or conform to a special pattern. Power requirements for the various cycles usually differ so that design for such items as adequate heat dissipation depends largely on full knowledge of this factor. If a system is being designed for operation at maximum power, without regard to duty cycle, the resulting systems will probably be unduly heavy and much more complex than necessary.

Intermittently operated equipment requires a knowledge of the periods and duration of operating cycles. Electronic gear may be operated only during certain phases of an airplane's flight or it may be operated intermittently. A fuel pump usually operates continuously until the tank it serves is emptied, then becomes inoperative for the remainder of the flight. In contrast, fuel level float valves may oper-

the Functional Aspects of a Design

(j) Strength
(k) Rigidity
(l) Input vs output motion
(m) Input vs output force

(2) Electrical and Electronic
(a) Frequency regulation
(b) Voltage regulation
(c) Compatibility of components
(d) Feedback
(e) Noise (hash)
(f) Arcing
(g) Microphonics
(h) Saturation
(i) Grounding
(j) Static charges
(k) External interferences

(3) Hydraulic & Pneumatic
(a) Pressure regulation
(b) Sealing
(c) Surge loads
(d) Pressure drop
(e) Flow rates
(f) Compressibility
(g) Valve characteristics
(h) Chatter (instability)

IV. HUMAN FACTORS

(1) Availability of controls to operator
(2) Optimum arrangement of controls
(3) Color in control handles
(4) Special shapes on control knobs

Fig. 1—Up-lock for airplane landing gear has combination of electrical and mechanical drives to fulfill functional requirements. Dependability under various environmental conditions is essential.

ate intermittently throughout a flight at more or less regular intervals. By analyzing operating conditions carefully, it is possible to put realistic values on the functional requirements.

A comparison of the number of cycles required for different items can be made between an airplane landing gear and a motor that drives a radar scanner. Assume the maximum useful life for a given airplane is 1,000 hr and the average length of flight is two hours. Since the gear is cycled once for every flight, there would be 500 required cycles during flight operations. To this must be added the cycling required as normal ground procedure whenever the gear rigging is altered during servicing. This might be another 500, or a total of 1,000 cycles. Compare this with the motor that drives the vertical strokes of a radar scanner. Six times every second, this motor comes to a full stop at the end of its motion, rests, and then reverses. Assuming the radar is operated during 80 percent of the airplane flight time, or 800 hr, the motor must be capable of operation through at least 17,000,000 cycles.

Highly elaborate sequencing operations are required of some systems. For a retracting landing gear, these may be largely mechanical—unlocking the down-lock mechanism, opening a door, retracting the gear, closing the door, locking the gear in up-position, and locking the door.

Electrical sequencing is frequently an important factor. In the case of the landing gear, Fig. 1, limit switches may indicate that the gear is up and locked, or down and locked. Even in such simple installations, failure to analyze carefully the functional requirements and conditions can lead to unnecessary troubles.

A problem—in the form of a

"warm-up time" requirement—has arisen in a number of systems. For one aircraft radar system, a warm-up of four minutes was required, which was approximately the total time required from scramble signal to combat altitude. Compared to this, an intervalometer (armament timer) took 0.005 sec to reach full speed; even this was too long for the intended use.

Hydraulic systems also have "warm-up" requirements when operating at very low temperatures. Small orifices strategically located in the lines have often been the answer.

In certain a-c powered electrical units, precise operation depends upon the accuracy of frequency regulation. Even an airplane of moderate size may require as much as 40 kva of alternating current. Close regulation of so much power aboard an airplane has presented the manufacturers of constant speed drives with some difficult functional problems. At the same time, it has made them look over the system to see if there are other means of attaining accuracy.

This problem of regulation is also important in hydraulic systems. If a control actuator is designed for a 3,000 psi system, it is assumed that 3,000 psi will be available for control because full-load operations may be impossible without it. Conversely, pressures must not exceed the design value, since the components in the system have been designed to operate only up to this pressure.

Environmental Factors

It is essential that environmental factors be considered during the design of any component. A part may operate satisfactorily during a routine laboratory test at normal temperatures, but be wholly unacceptable in service.

The problems of high and low temperature operation must be met by virtually every item of equipment which operates out of doors. Current aircraft specifications call for qualification at —65 F and +160 F, with the implication that each unit must operate satisfactorily at any temperature in this range.

The upper limit of these specifications is no longer satisfactory, and parts are already being required to operate above the limit, mainly because of aerodynamic heating. When an airplane flies at high speed, the air surrounding it is heated by kinetic action. Thus, any air taken aboard, such as for cooling purposes, experiences this adiabatic rise. Stagnation temperatures for planes now on the drafting boards are in excess of 200 F. With equipment qualified for use at only 160 F, it is necessary either to limit the airplane speed-altitude combination to avoid the higher temperatures (restrict the speed at low altitude) or to refrigerate all equipment under these conditions. While this may be a boon to manufacturers of refrigeration equipment, it is a headache to airplane designers.

The temperature limit is also exceeded around units mounted in engine compartments, as well as in crowded spaces where electronic components and other heat-generating equipment are housed. One aircraft armament fire control system has 89 separate "black boxes," nearly every one of which is a heat-producing unit.

The heat problem is present in many forms. Co-axial cable is filled with a plastic material which flows at temperatures above 170 F, thereby limiting its use. Since copper wire loses conductivity as temperature rises, heavier gages must be used in high-temperature areas.

Of special interest is the behavior of ordinary aircraft structural materials above 200 F. The 24S and 75S aluminum alloys lose approximately 10 percent of their strength at 200 F. At 250 F, 24S is down to 80 percent of room temperature strength, while 75S is approximately 65 percent. At 300 F, the values are 60 and 40 percent, respectively.

Analysis indicates that components exposed for long periods to low temperatures remain at low temperature for a considerable time, even though the surrounding air is warmed to a comfortable temperature. This is the situation in arctic operation. Parts that must operate throughout a temperature range of 225 F or more can have troubles from this source. Close-fitting running parts are especially susceptible, but just as important are press-fit parts that may be loose at one temperature extreme or the other.

Perhaps as important as the absolute temperature values, are the problems of thermal shock or rapid changes in temperature. An extreme case is the turbine wheel of a jet engine. On starting, a cold wheel is subjected to gas temperatures of 1,200 F; seconds after ignition it is under heavy load.

In addition to the heat problem, other environmental factors require consideration. In vehicles that operate in the desert, dust and sand become problems. Many areas are ventilated by ducted air from external sources, and the functional units in these areas are subjected to whatever dust and sand enter with the cooling air. Aircraft parts must be designed for these conditions too, although the problem is normally severe only near the ground.

Vehicles operating near the seacoast are subjected to salt water corrosion; only meticulous attention to the protection of components can prevent these effects from becoming serious. Salt spray penetrates the working parts of operating units unless they are carefully sealed. This problem is particularly severe in aircraft, because of the extensive use of very thin materials and light alloys. Magnesium presents serious problems but has performed successfully when properly protected.

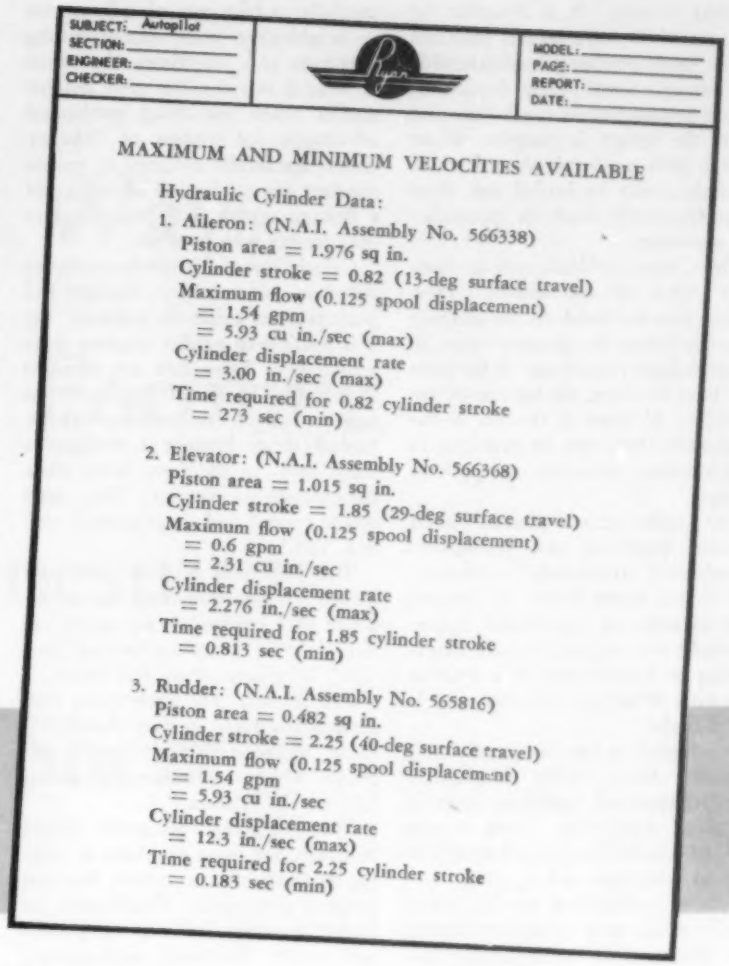
Other items of equipment may have their own corrosive environments. Parts operating in fuel systems, especially with aromatic fuel, are a good example. Of course, equipment used to handle acids or foodstuffs has to meet extreme conditions of corrosive environment, which, in this one respect, are much more severe than those that normal equipment must handle.

In tropical climates, there is the problem of fungus growth. Many organic materials, and particularly fabric materials, are subject to fungus dam-

age. Test procedures for fungus susceptibility have been set up and are a requirement for aircraft functional components.

The effects of altitude on functional requirements can be serious unless atmospheric conditions are carefully analyzed in advance. At reduced air pressures, electrical equipment is subject to arcing. This has led to the development of special contactor and insulating materials, as well as various methods of supercharging equipment. Another effect is related to the heat problems described above. High-altitude air is often too thin to provide adequate cooling.

In aircraft applications, vibrations and acceleration problems need special attention. More careful dynamic analyses are required than in many other industries, simply because additional weight is permissible only in the critical areas—and then as a last resort.



SUBJECT: Autopilot
SECTION:
ENGINEER:
CHECKER:

Ryan

MODEL:
PAGE:
REPORT:
DATE:

MAXIMUM AND MINIMUM VELOCITIES AVAILABLE

Hydraulic Cylinder Data:

1. Aileron: (N.A.I. Assembly No. 566338)
   Piston area = 1.976 sq in.
   Cylinder stroke = 0.82 (13-deg surface travel)
   Maximum flow (0.125 spool displacement)
   = 1.54 gpm
   = 5.93 cu in./sec (max)
   Cylinder displacement rate
   = 3.00 in./sec (max)
   Time required for 0.82 cylinder stroke
   = 273 sec (min)

2. Elevator: (N.A.I. Assembly No. 566368)
   Piston area = 1.015 sq in.
   Cylinder stroke = 1.85 (29-deg surface travel)
   Maximum flow (0.125 spool displacement)
   = 0.6 gpm
   = 2.31 cu in./sec
   Cylinder displacement rate
   = 2.276 in./sec (max)
   Time required for 1.85 cylinder stroke
   = 0.813 sec (min)

3. Rudder: (N.A.I. Assembly No. 565816)
   Piston area = 0.482 sq in.
   Cylinder stroke = 2.25 (40-deg surface travel)
   Maximum flow (0.125 spool displacement)
   = 1.54 gpm
   = 5.93 cu in./sec
   Cylinder displacement rate
   = 12.3 in./sec (max)
   Time required for 2.25 cylinder stroke
   = 0.183 sec (min)

Fig. 2—Sample page from functional analysis of hydraulic cylinders used in aileron, elevator and rudder controls.

System Characteristics

There are a number of mechanical characteristics that come under the general heading of "accuracy." These are especially important in the design of control devices. A careful study of each item is normally required before a reasonable set of tolerances can be established for the mechanical parts of any control system.

The first "accuracy" item is backlash. In a gear train, this is an accumulation of tolerances in the gears and their mountings. There are many other cases of backlash that are neither so easily visualized nor simply defined. In a hydraulic control, Fig. 2 there may be a dead spot at neutral position where there is no force in either direction. There may also be a zone on either side of this dead spot where the force vs. displacement curve is nonlinear. In high pressure systems, this curve is very sensitive to orifice shape, thereby making it imperative to know in advance the required conditions.

Another form of backlash occurs when a flexible connection is used between the input and the output ends of the system. A typical illustration is a cable control system where stretch must be considered. In a long run of cable, backlash can be an appreciable factor.

The second "accuracy" item is minimum increment of control. In an automobile steering mechanism, this increment is very small; in early power steering experiments, the minimum increments were large enough to be noticeable to the operator and so were considered unacceptable.

Many control devices have increments composed of definite steps. In others, the increment may depend upon such fickle quantities as the difference between static and kinetic friction or upon "stiction" in a valve spool. Here, the value can vary from unit to unit, be different on a warm day or a cold day, or even depend upon whether the unit has been recently operated.

Another group of "accuracy" considerations includes position lag and

position accuracy. It is desirable for any control to have output positions follow input positions instantaneously and exactly; some purely mechanical devices approach these conditions. But where the system is complex, where flexible links are involved, and where backlash cannot be loaded out, these items frequently result in unsatisfactory operation.

These same problems exist in many other types of mechanisms. How closely does the hand on the airspeed indicator follow the pressure values in transient flight conditions? If the pressure lines are long, the lag can be appreciable. If there is friction in the instrument, there may be problems in both minimum increment and position accuracy.

Still another set of "accuracy" items includes overshoot and springback. Overshoot is particularly troublesome with electric motor drives. It is impossible to stop any mechanism instantaneously, and stopping a motor that is turning at 10,000 rpm in a fraction of a turn, while not instantaneous, is still difficult.

In addition to the "accuracy" items discussed above, other mechanical characteristics are important from a functional standpoint. These include nominal travels, travel adjustment, mechanical advantage and friction.

In most applications, nominal travel would appear to be a simple calculation. But even in the seemingly simple cases, it is advisable to establish the travels of linkages and bellcranks carefully to take care of adjustments in neighboring parts, manufacturing tolerances and, sometimes, the effects of wear in service. The same analysis applies when specifying mechanical advantages for systems of linkages. Unless specifically designed to remain constant, the mechanical advantage of a linkage system will probably vary considerably with position.

Calculations of friction in a complex system of cables, pulleys, linkages and gears presents a difficult problem. Yet it is possible to predict frictions quite accurately if basic data are obtained from tests. In aircraft flight control systems, friction can become a very important factor because it produces a sharp break in the force curve when the controls are reversed. This causes erratic control and unsatisfactory control "feel".

The differences between static and kinetic friction can lead to erratic action of a mechanism or control device, since the breakaway force or "stiction" is greater than the force of kinetic friction. The latter varies with surface materials, surface finish, velocity, temperature and foreign materials, which may either lubricate or increase the friction.

The foregoing discussion shows that there are many problems in making a series of components function properly as a system. To illustrate the interrelationship between component and system functional requirements, take an electrical system composed of a 28-v d-c power source, an inverter, a voltage regulator and a radar set. Each unit can be tested thoroughly and shown to perform normally, yet be entirely unsatisfactory in a system unless the exact *system* requirements are used in the component tests.

Some of the more common system problems crop up in this electrical system. It is not uncommon to have feedback loads in the system which cause erratic voltage regulation. This is especially true when the load includes strong transients. In other cases, the inverter may have a response time too long to follow the load requirements and consequent signal from the voltage regulator. And system noise ("hash") may be so great that radar detection is impossible.

Another problem arises when a human operator is the medium for closing the loop in a system. Elaborate tests have been run to determine human response characteristics so that such loops can be studied by mathematical means. Of necessity, statistical data represent the average operator.

Occasionally, a peculiar vibration problem crops up. For years, aircraft instrument panels were attached to the airplane structure by shock-mounts to keep the instruments from shaking themselves to pieces from vibration induced by reciprocating engines. When jet engines were installed in early jet models, some of the instruments failed to function smoothly *because there was no vibration*. No one had thought to include *absence* of vibration as an environmental requirement.

Functional Quality and Malfunction Analysis

The term "functional quality" means that a part is adequate for the purpose intended, *but no better*. This involves both design and manufacturing methods. If a part is being machined to 0.001-in. tolerance when 0.010 is sufficient, it does not have functional quality. If a part on an expendable missile is cadmium plated when a cheaper finish would do as well, it does not have functional quality. The same analysis is applied to whole machines as well as to individual parts.

As stated above, any system of mechanization that is at all complex will more likely be successful if a careful functional analysis is prepared. But wherever a failure involves safety, as in almost any vehicle, a *malfunction analysis* should then be considered.

This type study is usually a systematic analysis of the effects of component failures, together with methods of preventing unsafe conditions. Such an analysis may start with a study of the probability of failure of various parts. Consider an aircraft flight control system in which the purely mechanical parts appear wholly reliable. The probability of failure in the control stick would be regarded as extremely remote. On the other hand, an electronic autopilot is subject to failure and the effects of such failure must be considered. If the failure of a vacuum tube or an electrical circuit can cause a "hard-over" signal in the autopilot, then some sort of protective device must be added to prevent such action or effects. Some of these safety devices have proved more difficult to design than the parts they are protecting. Regardless of complexity, the malfunction analysis definitely establishes the need for such protective devices.

Seven Ways of Forming Magnesium Sheet

1. *Bending*
2. *Rubber Die Forming*
3. *Solid Die Pressing*
4. *Drawing*
5. *Stretching*
6. *Spinning*
7. *Drop Hammer Forming*

Although magnesium is reputed to be difficult to form, the facts are that it can be fabricated with less trouble than most other sheet metals. Here are data, supplied by the production engineering department of Brooks and Perkins, Inc., on the processes generally specified

THE POOR FABRICATING qualities generally attributed to FS1-O or FS1-H24 magnesium sheet have factual basis only at room temperature. When heated to between 275 and 700 F, ductility increases so rapidly that ease of forming and drawing is greater than for aluminum, brass, or any of the ferrous alloys. Thus, it is possible to perform in one drawing operation what ordinarily would require three draws plus intermediate anneals to accomplish, and to obtain equal benefits in spinning, bending, stretching and other fabricating processes.

Prior to these operations, however, the sheet generally is pre-cut. The same procedures used for aluminum can be adapted with little change for magnesium. Shearing, sawing, routing, and blanking are the processes generally specified; all are similar in both technique and time to the methods used for cutting aluminum. However, magnesium shears differently from steel in that it appears to break about halfway through. Thus, punch and die clearance is held to about 1 percent as compared to one-tenth of the metal thickness for steel, and maximum sheet thickness is held to $\frac{1}{4}$ in. or less for blanking; as a matter of fact, $\frac{5}{32}$ in. is a more practical limit, although sheets have been blanked up to $\frac{1}{4}$ inch.

On a standard router, magnesium can be stack routed in thicknesses up to $\frac{5}{16}$ in. without burr. More chip

Table I—Forming Temperatures for Magnesium Alloys

Dowmetal Alloy	Condition	Working Temp. Range, F
FSI–O	Annealed	400–500
FSI–H24	Hard Rolled	275–300 max*
M–O	Annealed	550–650
M–H24	Hard Rolled	400 max

*300 F may be used if metal is at temperature 15 min. or less.

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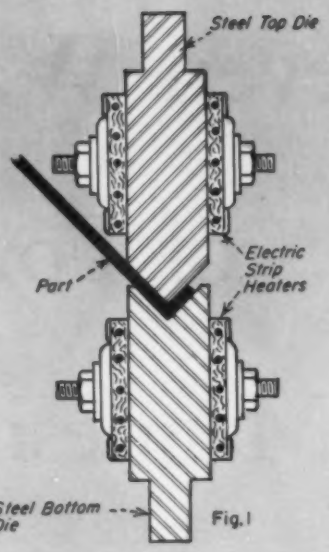

Fig. 1

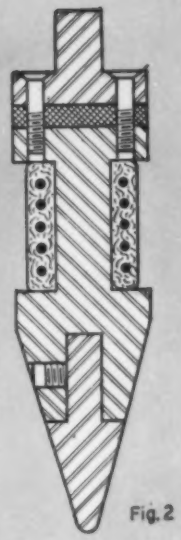

Fig. 2

Fig. 1—Electrically heated press brakes dies using strip heaters on top and bottom dies. *Dow Chemical Co.*

Fig. 2—Special upper die holder incorporating strip heaters for upper die. Note insulation between die holder and press to limit heat loss. *Dow Chemical Co.*

clearance can be used on the tool, and a single flute as compared to a two flute tool for aluminum, is practical because of freer cutting.

Sawing also is faster as might be expected, and along with shearing and routing, is used when anticipated production is too low to justify the cost of blanking dies. As between the aforenamed processes, cost and equipment availability are usually the determining factors.

All pre-cutting operations are done at room temperature. It is afterwards that the metal is heated to facilitate fabrication and prevent springback after severe forming operations. The temperature naturally is dependent on the sheet thickness, severity of operation, time at temperature, and composition and temper of the stock. Generally, FS1-O (annealed) is formed at temperatures up to 400-500 F, and occasionally as high as 700 F; FS1-H24 is held to 275 F max else it loses hardness above that heat. (Table I).

Gas heated hot plates are more or less standard for heating small diameter blanks that are to be shaped in form dies. Conveyor fed gas ovens are more practical for large blanks—especially those formed on draw dies —when production runs are substantial; portable gas fired ovens also are used. Torch heating is generally limited to low production parts, and while infrared electric ovens are satisfactory, they are expensive to operate. Most blanks for hydroforming are heated on blocks in gas fired ovens so that dimensions can be held and the blank can be put over die pins without difficulty.

Heating equipment generally is not built into a die. An ordinary gas pipe with No 40 holes on $\frac{3}{4}$ in. centers will generally hold a die at temperature if it is heated before being placed in the press. While crude, this method of heating is satisfactory, inexpensive, and can be used without change for a number of dies. Cartridge type electric heaters are usually confined to high production, high quality dies and are built into the block.

The forming method that is used after heating depends on several factors: availability of equipment, quantity of parts to be produced, part size and complexity, thickness of sheet, and tolerances to be held, among others. The simplest, and the method most often used for the forming of magnesium, is press brake bending.

1. BENDING

Straight short radius bends can be made on magnesium by press brakes, leaf brakes or by hand operation. The deciding factors are the amount of bend, length of bend and production quantity necessary. Die and rubber forming methods are used in flanging operations where right angle bends to each other would complicate press brake operation. Various standard steel dies plus dies in which the upper blade is bottomed in rubber retained in a U-shaped bottom dies are used in brake processes.

Press brake dies can be heated by electric strip heaters, Fig. 1, as the flat surface presented by this type tool is ideal for this application. Heaters are not used on a female die that contains rubber. The dies should be insulated from the press to shorten heating time, to prevent the die from heating excessively, and to conserve heat. Bottom dies are easy to insulate; top dies more difficult; however, a special blade holder incorporating insulation can be used. A method of insulating is shown in Fig. 2, where temperature control may be automatic or manual.

Other heating methods preheat the

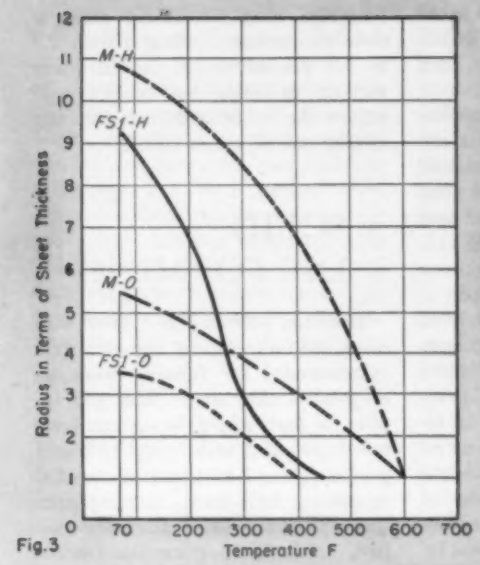

Fig. 3

Fig. 3—Minimum punch radius for magnesium alloy sheet. Curves are for 90 deg bends at various temperatures in terms of sheet thickness.

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Table II—Radii for 90 Deg Bends in Magnesium Alloy Sheet

Dowmetal Alloy	Condition	Min. Radii at 70 F	Typical Radii at Temp., F			
			70	300	400	600
FS1–0	Annealed	5t	4.5t		1–2t	
FSI–H24	Hard Rolled	10t	8t	4.5–6t		
M–0	Annealed	7t	5.5t		3–4t	1–2t
M–H24	Hard Rolled	12t	9t		6–7t	

Springback 8 to 10 deg for annealed sheet
12 to 15 deg for hard-rolled sheet

Dow Chemical Co.

magnesium sheet and heat the dies, heat the sheet by contact with the dies, or the sheet may be preheated and the die used cold. The last method should be used only where the operation is fast and forming is accomplished before the dies can chill the sheet. In making long bends the tendency of heat to cause warpage can be reduced if the dies are used at room temperature and the sheet heated.

Folding leaf brakes have not been used because of the heating problems encountered on standard equipment. Special types are being studied where the bending edge is insulated from the remainder of the machine. It is believed that the action of pulling the sheet being formed against the bending edge will stop the warpage problem encountered in making long free bends on a press brake.

Pre-production models are usually hand formed. The heated magnesium is hammered or bent over a model or block. Rubber, plastic, or soft metal hammers are used. Because most such hand forming is done hot it is usually necessary to use a metal block or model that has relatively good heat conductivity, yet will not melt or deform at the temperatures used. Heat is applied to the sheet by hand torches.

Suggested minimum bend radii in terms of sheet thickness for room temperature forming is show in Table II. The data were obtained by making 90 deg bends in both directions relative to the original flat sheet surface in 6 in. wide specimens with the bend perpendicular to the grain direction. Bends parallel to the grain direction can usually be made somewhat smaller than those listed as the sheet generally has better elongation in the traverse direction. The curves in Fig. 3, show the effect of temperature on the smallest die radii. These curves were obtained from testing material having typical properties but the values plotted are not to be considered typical because of the limited number of test bends made.

The above relates to the forming of minimum bend radii at elevated temperatures when fast acting bending machines are used. If hydraulic equipment is used having fairly slow forming action smaller bends can be made. FS1-O and M-O sheet have been formed to 90 deg bends with practically a zero radius on production items. Commercial M-O sheet has been bent through 180 deg with no radius at 600 F without cracking or alligatoring by using a press speed of 1 in. per min to finish the bend.

Extruded strip stock 0.090 in. thick may be bent to the value shown in Table III at room temperature. While these data are not of much value in predicting the forming limits on extruded shapes, they do show the relative formability of the materials.

J-1, M, and FS-1 extrusions may be worked quite severely at 600 F. If O-1 extrusions are to be aged after forming, forming is accomplished at room temperature as there is no advantage in heating the material up to 350 F, the maximum temperature that will not result in lowered properties.

2. RUBBER DIE FORMING

Rubber die forming or the Guerin Process, Fig. 4, is highly adaptable to shallow parts such as aircraft ribs, spars and fairings that do not require drawing action. While the labor cost per piece is higher than for die formed parts, the savings on die cost and the speed with which dies can be produced or revised overcome this disadvantage, especially when only a limited number of parts are required.

Special compound natural rubbers and synthetic rubbers have been developed that may be used with dies heated to 450 F. Slabs of rubber, with a 60 Durometer hardness, are cemented together to form a pad about 6 in. thick. For average forming a pressure of approximately 1,000 psi minimum must be applied.

Blocks for hot rubber forming are made from metals with melting points over 1,000 F. Metals with lower melting points have been found to creep excessively when subjected to the heat and pressure used in the operation. Magnesium or aluminum alloys, either machined from plate or cast shapes, have proven the most satisfactory as no allowance has to be made for expansion differences, they heat rapidly, are light and are easy to machine.

Various heating methods may be used. The one most extensively used involves an oven to supply the heat. A blank is located on a forming block by means of $\frac{3}{16}$ in. dia or larger pins and the assembly brought to heat in an oven after which it is formed in the usual manner. The only difficulty is that the forming platen must be insulated to prevent rapid chilling that occurs if the heated die were placed on a cold steel platen.

Table III—Room Temperature Bend Radii for Extruded Strip

Dowmetal Alloy	Bend Radius
01–T6	7.0–9.0t
01	2.0–3.0t
01–0	7.0–9.0t
J1	1.5–2.5t
M	4.0–5.5t
FS1	1.5–2.5t

Dow Chemical Co.

Another method is to heat the platen; the forming block bolted to the platen is heated by conduction. Blanks are heated in a preheating oven, then located on the forming block.

In the first method enough different parts must be available for a run so the dies can be circulated through the oven without having to wait after a part is formed for the die and new stock to heat. This method has the advantage that if handwork is necessary on the part it may be done as soon as the part and die are removed from the press while it retains sufficient heat. The second method is usually limited to parts which may be formed directly in rubber without handwork. If rework is required the part has to be reheated and formed on the die after the run has been finished and it is removed from the press. A further disadvantage is that the constant platen heat results in an earlier breakdown of the rubber than when it is intermittently exposed to heat. The electrically heated platen has an advantage where hard-rolled sheet is used in that the time at temperature may be held to a minimum and higher temperatures used without increasing property loss as shown in Fig. 5. If this method is used and the rubber becomes sticky the part may be protected from the rubber by covering the blank with a sheet of wrapping paper or dusting it with cornstarch prior to forming.

A forming temperature of 300 F for FS1-H24 sheet is usually used as this temperature results in only a 2 to 3 percent property loss when heated for 15 minutes. Stretch flanges of 40 percent have been successfully made at these temperatures. Flanges with 2.5 to 3.0 percent shrink can be made without wrinkling but smaller radii require the use of cutouts or crimping to take care of excess metal.

3. SOLID DIE FORMING

Hydraulic presses, Fig. 6, fitted with blank holding rams or cushions were recommended for forming work on magnesium alloy sheet. This still applies for parts where the slow uniform speeds obtained with typical hydraulic presses (about 2 to 4 fpm) are needed in making deep draws, forming parts such as boxes with small radius corners, making parts where the material must be severely stretched to make the shape and others. Recent work on mechanical presses fitted with hydropneumatic or pneumatic cushions, however, has indicated that these presses are equal to and in instances superior to slow hydraulic presses.

Parts that tend to pucker on the punch, for example those having irregular rounding contours, have been formed at average speeds of 60 fpm with less trouble than on hydraulic presses with a speed of 3 fpm. The reason for the reduced puckering is probably that the greater speed gives

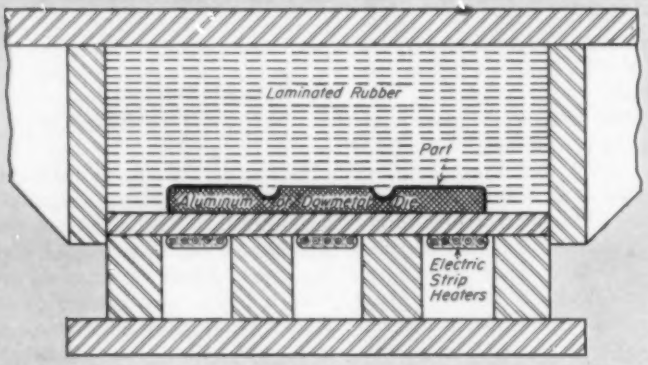


Fig. 4

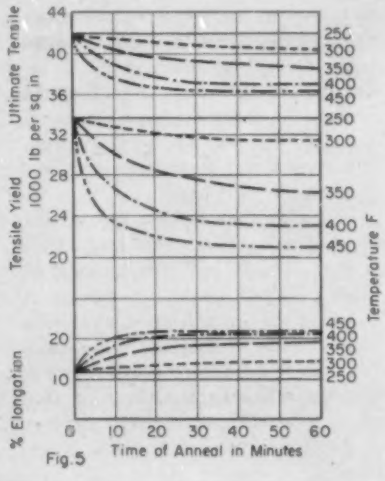


Fig. 5

less chance for the unsupported metal between the nose of the punch and the radius of the draw ring to cool and increase the puckering tendency.

Single action presses not equipped with cushions may be used for hot drawing work by using springs or by clamping the holding plate with C-clamps or other mechanical means. These expedients are only recommended for temporary use, however, as springs lose their temper when exposed to the die temperature and the mechanical clamping means are slow and awkward to use. Control of clamping pressures is also inferior. As most presses may be fitted with cushions, this course is usually taken.

4. DRAWING

Alloys of magnesium can be drawn from three to four times as deep in one operation as aluminum or steel. This property makes it practical to fabricate in one piece a part which, if made from other metals, would usually be fabricated by riveting or welding several pieces together. The fact that large pieces can be made from a single draw does away with all intermediate anneals and only one set of dies are necessary. (Figs. 7 and 8).

As a general rule, magnesium alloy parts can be drawn in one operation to a depth of from 1½ to 2 times the minimum width of the part. From a circular blank, the depth of draw can equal twice the diameter of the drawn part. Within reasonable limits, the thicker the sheet, the better the draw and the more easily it is formed. However, successful deep draws have been made from material as thin as 0.020 in. and as thick as ⅜ inches.

The main difference in dies for working magnesium alloy sheet is that provisions must usually be made for heating, Fig. 9, and allowance must be made for difference in coefficient of expansion when materials other than magnesium alloys are used in the dies.

In parts where it is physically possible to form the material to the punch by the pull exerted on the blank by the pressure ring and draw ring, an open type die construction is used; the female die does not bottom on the punch. Usually mating dies are not necessary; however, they are used for parts having embosses or re-entrant portions.

Pressure rings and draw rings are usually made from mild steel plates. In making dies from mild steel it is important that the material be stress relieved at 1,200 F for one hour and air-cooled before finish machining to relieve stresses that might cause the die to warp in service. Even so, some mild steels have been warping in service and heat resistant tool steel, not hardened, is being tested. Heat resisting Meehanite cast iron has been tried and it has proved superior to mild steel. While the cost of Meehanite is higher than mild steel, the machining and polishing operations may be done in less time and this should offset the material cost.

Punches are made from steel, cast iron, magnesium alloys and aluminum alloys. Magnesium alloys are used more than the other materials as they have the advantage of good machinability, they do not need correction for expansion caused by heating, and, especially in large dies, their low weight facilitates set-up and removal of the punch from the press.

As the coefficient of expansion for magnesium alloys is greater than for steel and aluminum, allowance for the difference must be made when using the latter materials in die construc-

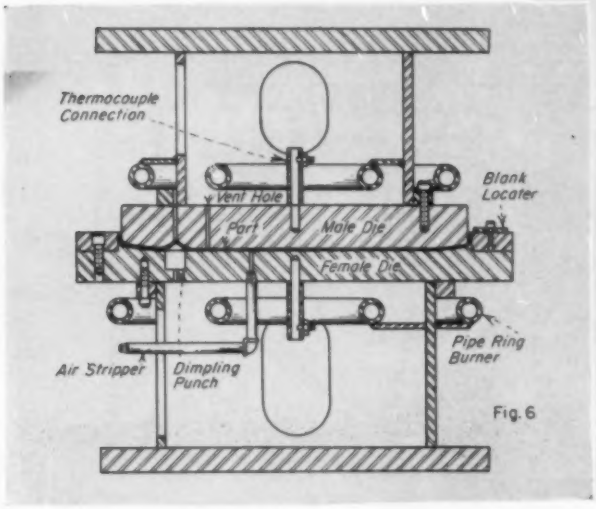


Fig. 6

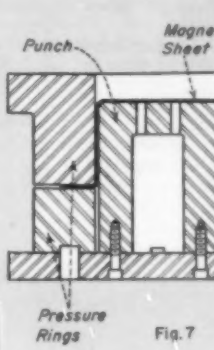


Fig. 7

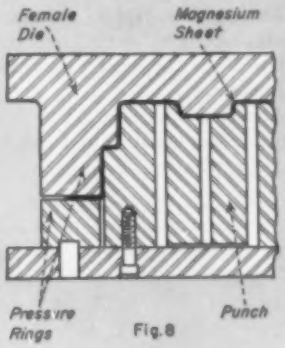


Fig. 8

Fig. 4—Rubber forming die with strip heaters attached to platen. Die is heated by conduction. *Dow Chemical Co.*

Fig. 5—Effect of annealing time and temperature on the room temperature properties of FS1-H24 sheet. *Dow Chemical Co.*

Fig. 6—Typical solid die forming of magnesium sheet. Note punch for dimpling operation. *Dow Chemical Co.*

Fig. 7—Diagram of die for deep drawing magnesium sheet. This die-set consists of punch and pressure rings. No female die is used.

Fig. 8—Half section of die-set for deep drawing mag. Female die is combined with top pressure ring.

tion. In designing dies all dimensions that affect part size should be multiplied by a factor of 1.004 for steel and cast iron; and 1.002 for cast aluminum when the dies are to be operated at 600 F. If dies are to be run at temperatures other than 600 F the factor, Fig. 10, should be proportionately corrected.

Clearances between the male punch and the female die should never be less than the metal thickness. For deep draws, it should be more than the metal thickness as the compression causes a thickening of the metal during drawing. For deep draws the clearance should equal about 1.1 times the metal thickness being drawn, plus the thickness of the blank.

The thickness of plates used for draw rings and pressure pads should be sufficient to avoid danger of distortion when heat is applied. For this reason, plate less than 1.5 in. thick is not used, Table IV. The radius of the draw ring affects the drawability of metal. Magnesium sheet has been drawn with draw ring radii from 4 to 15 times the sheet thickness; but for most deep draws, best results are obtained with a minimum value of 8 times the sheet thickness. Too small a radius increases drawing resistance and limits depth of draw; too large a radius causes the metal to pucker during drawing.

Annealed blanks can be drawn at temperatures varying from 400 to 650 F. Alloys having low melting points should be kept at 600 F or less. Hard rolled metals must be drawn at about 400 F.

When deep drawing annealed blanks, the thickness of the finished parts may be controlled by the drawing temperature. For instance, if a part is found to be slightly over the tolerance limit when drawn at 550 F, an increase in temperature to 600 F or more will result in greater shrinkage of the part upon cooling, also more expansion of the dies at drawing temperature. This will decrease the finished part dimension and bring it within the desired limits. The wall thickness at the sides and bottom can be maintained, and thinning of the section prevented by using a hot blank and die with a cool punch. The hot plastic material is drawn over the draw ring radius. It is cooled by the punch, which increases its tensile strength during the draw.

The tensile strength and elongation of annealed sheet at elevated temperatures are shown in Fig. 11. Forming temperatures up to 700 F may be used without affecting the strength of annealed sheet. For best results forming should be done in the 450 F. range.

Table IV—Plate Thickness for Die Rings

Largest Blank Dimension in.	Min. Plate Thickness in.
0–14	1.50
14–22	2.00
22–30	2.50
30 and over	3.00

Dow Chemical Co.

5. STRETCH FORMING

Stretch forming is extensively used by the airframe industry with success.

Work at room temperature has been limited to annealed sheets and the operation is essentially similar to the working of aluminum. The main precaution is that sharp, serrated grips should not be used. If a machine has grips that tend to cause failure of the sheet, or if slipping is encountered, the trouble may be overcome by lining the grips with emery cloth. However, heat is required for severe forming.

Usually the metal is heated by conduction from the die. Compound curvatures require selective heating of the sheet by torches. Simple curvatures may be formed by using a cold die with a fiberglas blanket between die and heated sheet. Electrically heated dies can also be used; the part being formed by pressing the sheet between the die and a mild steel strap which is held in the stretch-press grips.

6. SPINNING

Magnesium is well adapted to hot spinning techniques. Small quantities of parts may be spun to close tolerances with inexpensive tools. Parabolas of 0.064 in. FS1-O have successfully been held to 0.012 in. and the parts operated within electronic tolerances.

Fig. 9—Typical heating arrangement used on dies for the deep drawing of magnesium. Gas heating rings of this type are inexpensive and can be easily modified for die changes.

Dow Chemical Co.

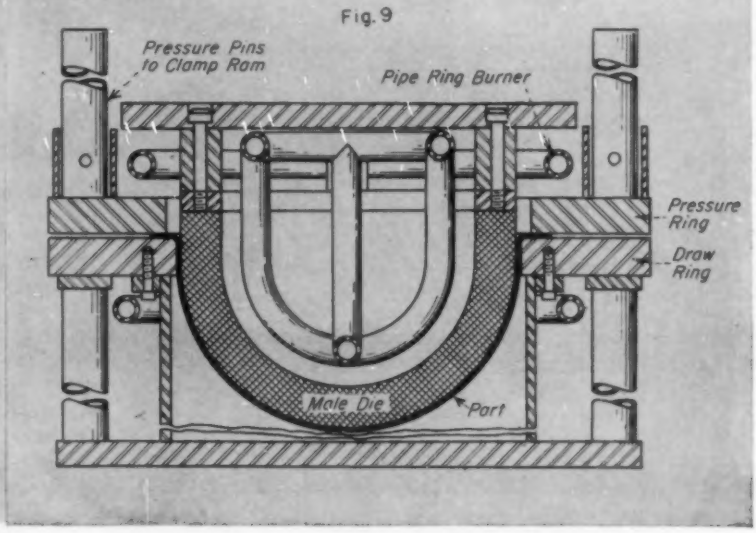
Fig. 10—Curves for determining die dimension factors at various forming temperatures for aluminum and steel dies. No factor is necessary when magnesium dies are used.

Dow Chemical Co.

Fig. 11—Properties of annealed sheet at elevated temperatures. Best forming temperature is where tensile strength and elongation curves cross.

Dow Chemical Co.

Fig. 9



Many other parts are being spun, ranging in thickness from 0.032 in. to over 0.125 inches.

Two types of spinning are used. In the first, the spin block is made of aluminum, cast iron, magnesium, or steel, and are heated prior to the spinning operation. The other method uses wooden or Kirksite spin blocks and the magnesium is heated while the spin block is kept as cool as possible.

7. DROP HAMMER FORMING

Drop hammer forming of magnesium is being used by many of the aircraft manufacturers forming FS1-H24 and FS1-O sheets. At elevated temperatures, about 550 F, magnesium is fairly easy to form and parts which would require several blows for cold forming aluminum can usually be formed with one blow from heated magnesium.

Kirksite dies and lead punches, standard tooling when forming aluminum and annealed steel, are used for magnesium but require adaptation.

The first consideration is to obtain dies that will withstand the expected temperatures, and that will contract to design size at room temperature. Also, more attention must be paid to the need for restraining beads and trapping surfaces than is necessary in forming aluminum or steel. Since the dies are worked at high temperatures they will be in danger of damage because of creep or impact flattening. Since hot forming magnesium alloy sheet cannot stand high impacts the Kirksite dies can be lower in height so that the lower die cavities are nearer the source of heat.

From metallurgical data, zinc base die alloys are not considered reliable for long production runs at high temperatures. For runs of 50 parts or less Kirksite dies have adequate stability; for longer runs the dies should be recast or Mechanite castings used.

Currently, the lead punch is heated by conduction from the die to a temperature of about 200 F. The punch suffers considerable loss in compressive yield strength at this temperature; however, a female type die tends to reshape the punch with each stroke.

The tri-temperature situation that exists in drop forming; that of the material heated to 500 F, the die at 300 F and the punch at 200 F, causes a tolerance problem. Investigations indicate that an interference between part and die becomes a maximum of 0.003 in./in. of die surface for Kirksite dies. Sometimes this interference is used to control springback.

However, as drop hammer forming is not a precision method, tolerances on finished parts should be analyzed from a die conformity standpoint. Part accuracy when compared to the die indicated that better reproductibility was obtained in magnesium than with aluminum or steel; the error averaging about ±0.050 inches. The general production tolerances for aluminum and steel of ±0.03 in. is applicable to magnesium parts.

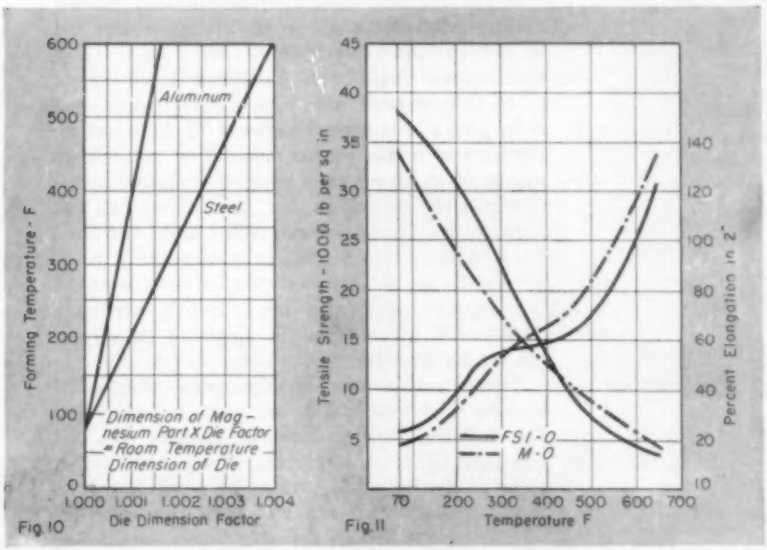
Die heating is accomplished in two ways. Small dies are anchored to the surface of an electrically heated Meehanite platen installed on the bed of the hammer. With the platen normally operating at 500 F the Kirksite dies reach equilibrium at about 300 F. This is considered an allowable maximum for prevention of creep or danger in flattening. Lead punches are used because of their simplicity of fabrication and are heated by conduction from the die. Temperature of the punch will be about 200 F, again felt to be the allowable maximum for prevention of creep.

Large dies cannot be adequately dogged to the platen, as eccentric loading would cause horizontal force components of sufficient magnitude to cause die shifting. The die is, therefore, placed on the press bed and about one in. of molten lead poured over the exposed bed surface. The dies are heated to 300 F with a Propane burning torch.

General purpose heating of flat sheet and formed parts is done by using circulating air type furnaces. Oven air temperature is set for 550 F. Generally, heating times of 5 min. per stage for gages in the 0.051 in. range and 9 min. per stage for 0.125 in. gage is considered staisfactory.

For drop hammer forming it is recommended that only condition "O" material be used. The detrimental effect of rapid strain rate at the normal lower working temperatures of "H-24" condition magnesium is the reason for minimizing its usage to parts needing limited forming. It should be limited to simple shapes having maximum compression of 5 percent or pure stretch of 10 percent.

When magnesium is hot formed its formability equals that of 3S-O aluminum and fewer compression wrinkles result than when 24S-O is formed in the same dies. Temperature variations and the extreme speed of the operation make severe drawing difficult, therefore, drop hammer forming should be limited to shallow draws, stampings, asymmetrical shapes and special cases of springback control, all done in the 550 F range.



A magnetic particle clutch is a controllable coupling that utilizes the action of magnetic metallic particles in a magnetic field between two independent rotating members — a driving element and a driven element, both fabricated in whole or part of magnetic material — to transmit torque.

The magnetic field, produced by passing current through a coil, generates a binding force, or torque, that is approximately proportional to the coil current up to the point of saturation of the magnetic circuit. Applying low power d-c control current to the coil permits: (1) fast response with high power handling capacity; (2) ability to transmit continuously variable torque; (3) operation at a wide range of speeds and torques; (4) long life and continuous operation with negligible wear; (5) easy adaptability to remote or automatic control; (6) smooth engagement, with no chatter or grab; (7) operation in either direction; (8) use as a clutch or brake; (9) operation over a wide temperature range with stable characteristics; (10) quiet operation; (11) little or no maintenance; and (12) large ratio of capacity to size when compared to friction clutches.

With these characteristics, the magnetic particle clutch is eminently suited for applications requiring controlled mechanical power transmission, ship service, accurate torque control, or positioning. It may be used for simple on-off clutch duty, as a torque limiting clutch set to slip when preset torque values are exceeded (the torque transmitted is practically independent of slip speed), for applications involving sudden reversal of rotation, and as a brake exhibiting essentially no wear, in place of conventional friction-type brakes.

There are two general types now being used. In one, a liquid vehicle, such as oil, suspends the iron particles and serves as a source of lubrication as well as a protective coating inhibiting oxidation of the iron powder. This type has some disadvantages, however, such as the necessity of using special seals, the possibility of oil leakage, sedimentation of the suspended particles, wear of lubricated surfaces, etc. In the second type, there is no liquid present. The iron particles are dispersed in the air gap. Additives, in the form of dry powders, generally serve as lubricants, and prevent physical and chemical changes in the iron particles which might affect clutch operation. Extensive reports and research data are available providing theories, explanations and experimental test data relating to the operation of both types of magnetic fluid clutches. In the appended bibliography, some of these are listed.

This article deals with a specialized application of a dry powder magnetic particle clutch of a design which, utilizing magnetic stainless steel powder without any additives, has exhibited improved operating and service characteristics.

Stainless Steel

ALVIN S. WEISS
Project Engineer
American Machine & Foundry Company

REPLACING CONVENTIONAL iron powder mixtures with magnetic stainless steel, without additives, promises to remove many of the shortcomings now associated with magnetic particle clutches. Difficulties encountered with iron powders are oxidation and contamination with oil and grease from bearings. Both conditions result in erratic performance.

Extensive tests with stainless steel powder, over a period of a year, have definitely shown it to give improved performance. For example, these clutches have withstood severe humidity tests, consisting of being heated to about 130 F at high humidity for 4 hr, then cooled back to room temperature for 4 hours. After 26 days of continuous cycling, only a negligible variation in clutch characteristics was detected.

Similar clutches using conventional iron powder mixtures showed changes in less than one day, and all failed to meet specifications after 3 days. These specifications required a minimum rated torque of 45 ft-lb at rated voltage, a maximum drag of 3 ft-lb, and a maximum breakaway of 5 ft-pounds. (Breakaway is the torque required to get relative motion of clutch members when de-energized immediately after the clutch has been driven at full slippage for several seconds when fully energized and then brought to rest still fully energized.) Average values for the stainless powder units were 50 ft-lb torque, 1 ft-lb drag and 2 ft-lb breakaway, a considerable improvement in operating characteristics besides the better service life.

Typical performance data for several commercial stainless steel powder units are given in Table I and Fig. 2. These data are based on clutches with coil windings rated at 100 volts. Comparable values apply to clutches with 6, 12 or 24 v coils.

The stable torque output of these clutches, after severe usage, is another desirable feature considering

Powder Magnetic Clutches

the wear that would occur in friction clutches under similar service. For example, a clutch operated at low speed (30-60 rpm) with full slippage under a cycle of 2½ seconds energized and 1½ seconds de-energized (15 full cycles per min) was tested for well beyond 600 hr of continuous duty (more than half a million cycles) and the torque remained constant. There was, however, a gradual dropping off of torque during the first 50 hr of such operation amounting to about 10 percent of the initial value, after which there was no further change.

Analyzing an application such as that shown schematically in Fig. 3 should help develop an appreciation of magnetic particle clutches in general and specifically, stainless steel powder types. Basically, what was required was a compact, remotely controlled drive unit to raise and lower a mass. In addition, provisions were required for interrupting the cycle at any point and permitting the mass to fall freely as quickly as possible, without hitting bottom. This meant that the momentum of the falling mass and rotating drum had to be absorbed by some snubbing means. A further requirement was that the deceleration be controlled to avoid shock loading the adjacent structure. The travel of the mass, normally driven at several feet per minute, was several hundred inches between the upper and lower limits.

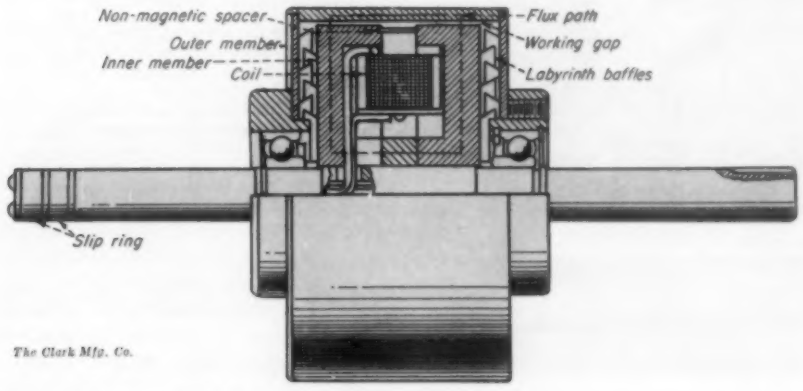
To accomplish an emergency drop in minimum time, and yet prevent the mass from hitting bottom with enough momentum to cause damage, it was decided that the mass should come to rest at an elevation of approximately one foot above bottom and be driven to its full down position at normal motor speed. The tolerance allowed on this one-foot dimension was plus or minus three inches.

Conventional friction disk electro-magnetic clutches were tried and found to be unsatisfactory. The rest position after drop, or final drop height, varied considerably with successive drops because of changes in the friction surface due to wear, temperature and humidity changes.

However, the stainless steel powder magnetic clutch, Fig. 3, was completely satisfactory. Several assembled actuators were made and subjected to a rigid life test as follows: The clutch was energized and the mass was raised up to its full height, then released under free fall and snubbed by re-energizing the clutch. This was continuously repeated for nearly ten thousand cycles and in all cases the final drop height was well within the permissible variation.

The snubbing or braking action was relatively simple. For normal operation, the clutch is continuously energized with d-c voltage through a normal circuit at about 75 percent of its rated current. When energized at rated voltage, the rated torque of the clutch is about 50 ft-pounds. The load imposed on the clutch by the weight hanging from the cable drum is about one-fourth of this value.

When an emergency drop is called for, the normal ener-



The Clark Mfg. Co.

Fig. 1—Typical magnetic particle clutch. It consists of two independent rotating elements, a driving and a driven member. They are separated by a space that is filled with a dry powder which, when magnetized, binds the two elements together.

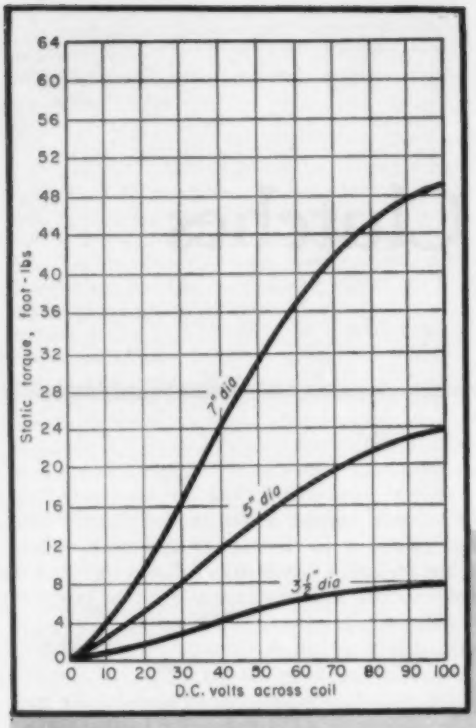
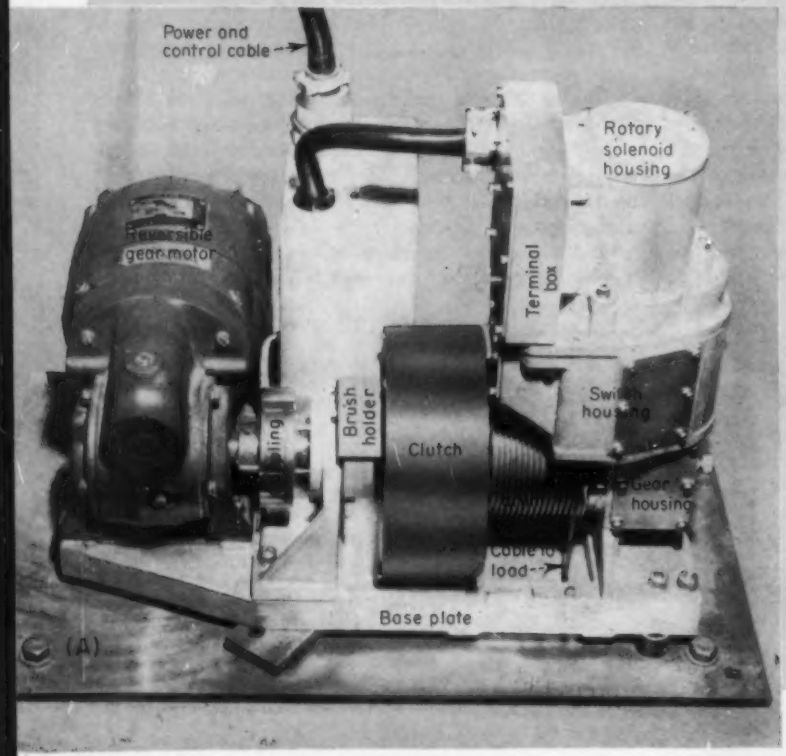


Fig. 2—Typical torque-voltage-data for stainless steel powder clutches with coil rated at 100 v d-c.

gizing circuit is interrupted, resulting in rapid decay of clutch torque to a minimum drag value of about 1 ft-pound. The mass begins to fall with an acceleration slightly less than gravity, and travels approximately one-half of its initial elevation above the reference level before snubbing voltage is applied to the clutch. Under such conditions, the mass will reach a final drop height of 1 ft and the decelerating forces will not exceed 2 g's. The snubbing voltage is applied to the clutch through a separate circuit.

Obviously, some means was required to re-energize the clutch at the appropriate point of the fall, regardless of the height at which a drop started. This is done with suitable gearing on a cam shaft, which feeds into a small mechanical differential. The second input to the differential is from a pinion on the cam shaft driving a gear, spring-loaded against a ratchet wheel pinned to the differential input shaft. This ratchet wheel is acted upon by pawls



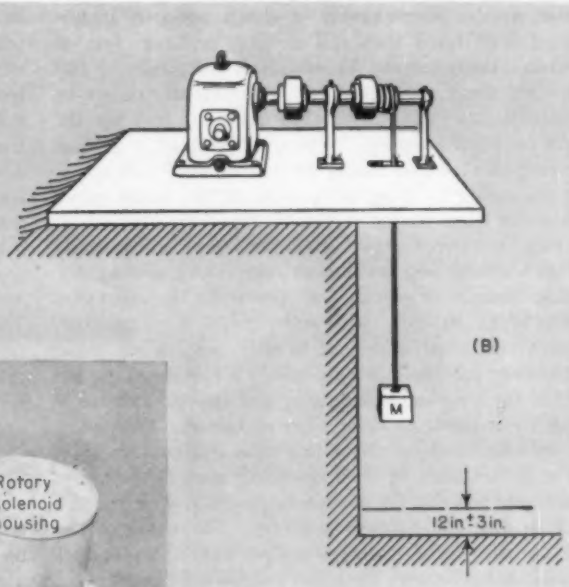


Fig. 3—Actuator package shown in (A) at left is considered to be typical of the critical applications for which stainless steel magnetic particle clutches may be useful. The clutch in this particular unit is used to provide a controlled, emergency drop in the raising and lowering cycle of a mass (see schematic in (B), above). Mass will fall freely from any position and will be brought to rest without shock at 12 ± 3 in. above bottom.

Table I—Performance Data for Typical Stainless Steel Powder Magnetic Clutches

Clutch Dia, in.	Weight, lb	Coil Power at 100 v, watts	Coil Current at 100 v, ma	Ampere Turns at 100 v
3.5	7.5	12.6	126	652
5.0	16.2	24.9	249	1000
7.0	31.2	21.4	214	766

cammed out of the way by the action of a normally energized d-c rotary solenoid. The differential output is fed to a cam actuating a switch, which closes the snubbing voltage circuit. In normal operation, the position of the ratchet wheel is related to the elevation of the mass, the solenoid being energized to cam the pawls free.

When emergency drop is called for, the solenoid is de-energized at the same time as the clutch since they are supplied from the same d-c circuit. De-energization of the solenoid permits the pawls to drop against the ratchet teeth and prevent ratchet wheel motion before the mass begins to fall, thus establishing information as to the height from which the mass is dropped. This, in turn, determines when the action of the snubbing switch occurs, which is at an elevation of approximately half that from which fall began. Since, during the fall of the mass the ratchet wheel is prevented from turning, additional spring windup occurs between it and the gear against which it is spring loaded.

When return to normal position is desired, a reset circuit energizes the clutch through its normal circuit at the same time re-energizing the solenoid. This latter action cams the pawls out of the way permitting the ratchet to automatically reset itself for normal operation.

Since there is a certain variation in the clutch characteristics due to manufacturing tolerances—in the order of plus or minus 5 percent maximum—the snubbing circuit of each actuator contains a rheostat which is adjustable to give the desired final drop height for the particular clutch used in the actuator. Once set, this needs no further adjustment. Without exaggeration, it is probable that the successful acceptance of this actuator package is largely due to the excellent characteristics inherent in the design of the clutch as finally evolved.

SELECTED REFERENCES

1. "The Magnetic Clutch", National Bureau of Standards, Technical Report No. 1213, April 1948.
2. "Investigation of Characteristics of Magnetic Fluid Clutch," Thomson Laboratory, General Electric Co., Schenectady, New York.
3. "The Magnetic Fluid Clutch Comes of Age," *Product Engineering*, Vol. 21, No. 7, July 1959, pp. 141.
4. "Investigation of the Response Time of Magnetic Fluid Clutches," Report by W. A. Notz, National Bureau of Standards, Sept. 26, 1950.
5. "Dry Friction Clutch as Servo Drive," F. S. Maleck, *Product Engineering*, Vol. 21, No. 9, Sept. 1950, pp. 146-149.
6. "Further Development of the NBS Magnetic Fluid Clutch," National Bureau of Standards, Technical Report. No. 1493, Dec. 1950.
7. "The Magnetic Particle Power Clutch," Electrical Engineering, April 1951, pp. 327-328.
8. "Development of Magnetic Fluid Clutch," W. P. Jones, Interim Report No. 1, Shipboard Systems Branch, Electricity Div., Naval Research Laboratory, August 1952.
9. "Clark Dynamatic Drive," Descriptive Bulletin, Clark Mfg. Co., Cleveland, Ohio.

A FILM OPTICAL SENSING DEVICE

An instrument that rapidly and automatically processes information into a form suitable for direct input to large-scale electronic computers has been developed at the National Bureau of Standards for the Bureau of the Census. Named FOSDIC (Film Optical Sensing Device for Input to Computers), the machine reads marks on microfilmed copies of documents that have been marked with an ordinary pencil or pen. Then it processes the information into electrical pulses that are recorded on magnetic tape for direct input to an electronic computer such as the Census Univac. FOSDIC is designed to reduce the work of converting written records into a medium acceptable as input by data-processing machines.

FOSDIC was developed to bridge the gap between a computer and its sources of information, particularly for computing systems which perform relatively little computation on a large mass of data obtained from many sources. Although considerable attention has been given to computers and their input-output equipment, there has been relatively little emphasis on "pre-input" apparatus or instrumentation to put the computer in direct contact with sources of information.

The method of mark sensing used by FOSDIC is the detection of specific blacked-in areas or ovals in a large field of possible answers arranged on a sheet of paper. A "yes-no" answer is given two ovals; a numerical answer is supplied with a vertical column of 10 ovals for each decade. The desired information is indicated by the locations of the marks. The sensing equipment tells the computer which ovals the enumerator has marked to signify his available information. Since FOSDIC senses the presence or absence of a mark by optical means, readings are not affected by the electrical conductivity of the mark or the paper, or by any mechanical indentation of the paper.

The scanning process is carried out on a frame-by-frame basis. Each frame is a microfilmed picture of one side of a sheet which may be as large as 14 by 16 inches. The film is placed in an optical assembly between a cathode-ray tube with a moving spot that scans the image and a photocell that produces a varying electrical signal from the light beam that has passed through the film. The current maximum capacity is about 2,800 marks per sheet, since this is the present limit of adequate legibility of marks on the document. An individual film is scanned in 0.5 to 0.9 seconds. Allowing for film change and other functions, the total time per frame is about 1¼ seconds.

HOW TO SELECT VIBRATION ISOLATORS

THREE-POINT MOUNTING	1. Calculate loads supported by the three isolators using Eq. (1). 2. If all three loads lie within the load range of one particular isolator, use three identical isolators having that load range. 3. If the three loads do not all lie within the load range of the same isolator, use different load ranges at each corner so that each isolator is loaded as close to the middle of its load range as possible.
FOUR-POINT MOUNTING	1. From data such as that shown in Fig. 3(C), determine whether or not four identical isolators can be used, and if so, select the best load range. 2. If the cg eccentricity is greater than the allowable eccentricity for four identical isolators, determine the load supported on each isolator from Eqs (3c). 3. Select isolator load ranges such that each isolator is loaded as close to the middle of its load range as possible.
SIX-POINT MOUNTING EVENLY SPACED	1. Determine if six identical isolators can be used by determining the loads, from Fig. 4(B), that would be supported by six identical isolators. 2. If all six loads do not fall within the load range of one of the desired isolators, select isolators on the basis of the loads calculated from Eqs 4(f) such that each isolator is loaded as nearly as possible to the middle of its load range.
SIX-POINT MOUNTING OPTIMUM SPACING	1. From Fig. 5(B) and Eq 5(d), determine the desired spacing and load on each isolator.

SHELDON E. YOUNG

Manager, Chicago Office,
The Barry Corporation

IN SELECTING ISOLATORS, regardless of the number of mounting points, it is necessary to know the weight and center-of-gravity location of the unit accurately to provide the desired shock and vibration protection. Incorrect loading due to excessive eccentricity of the center-of-gravity can be just as detrimental as if the incorrect loading were due to excessive or insufficient stiffness of the isolators.

Best performance of the isolators in reducing shock and vibration is obtained if the equipment can be designed in such a way that the center-of-gravity falls midway between the isolators, thus allowing the use of identical isolators, with all isolators loaded uniformly. This is often possible in the early design of equipment. However, if it is not possible, the eccentricity of center-of-gravity must be taken into account so that the isolators will function as they are intended.

The ideal suspension is one in which the isolator stiffnesses combine in such a way as to provide a level mounting and to decouple the vibration in one plane from that in any other plane. However, since many standard mounts have large ranges over which they provide adequate performance, it is possible to use identical isolators if the eccentricity of the center-of-gravity of the unit with respect to the mounting pattern is within the limits which will load each of the isolators within its load range. In any event, it is necessary to know the weight and center-of-gravity when all cables and connectors are attached to the machine or equipment.

The most common mounting system is one in which the equipment is mounted on four isolators distributed in a rectangular pattern in a horizontal plane. For the purpose of this analysis it does not matter whether or not this plane is at the height of the center-of-gravity, although other factors may make it desirable to locate the plane of the isolators at the cg height in some applications and at some other height in other applications. Other mounting systems which are commonly used are the three-point suspension and the six-point suspension.

Vibration Isolation of Equipment With Eccentric Centers of Gravity

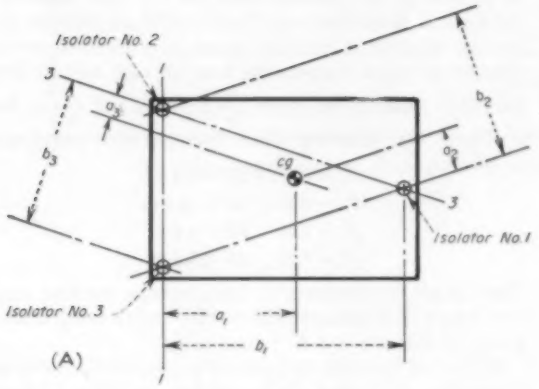


Fig. 1—(A) Plan view of a unit mounted on three isolators. (B) Example of a piece of equipment on three isolations. Solution (see text) shows how three identical mounts can be selected for this installation.

THREE-POINT MOUNTING

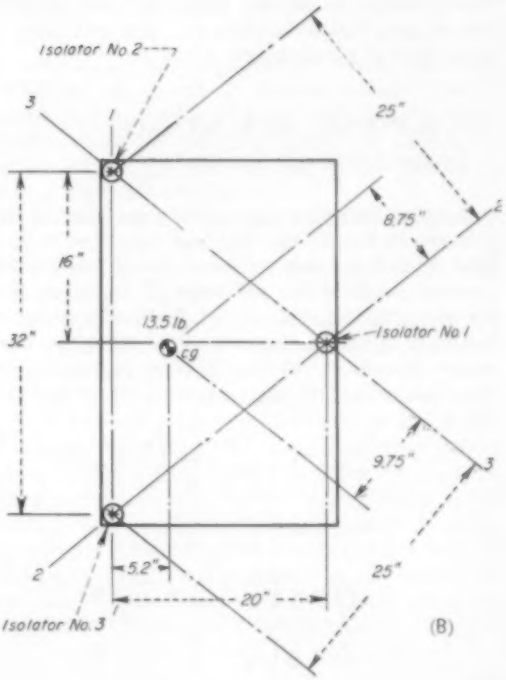
Fig. 1(A) shows a plan view of a unit mounted on three isolators. The weight supported by each isolator is independent of the stiffnesses of the isolators and is determined by the summation of moments about axes, 1-1, 2-2 and 3-3, respectively.

$$\text{Load on Isolator No. 1} = P_1 = \frac{a_1}{b_1} W, \qquad (1)$$

$$\text{Similarly,} \quad P_2 = \frac{a_2}{b_2} W \quad \text{and} \quad P_3 = \frac{a_3}{b_3} W$$

The same load range can be used for each of the three isolators if the values of P_1, P_2, and P_3 are within the load range for which the units are designed.

For example, Fig. 1(B) shows a unit weighing 13.5 lbs.,



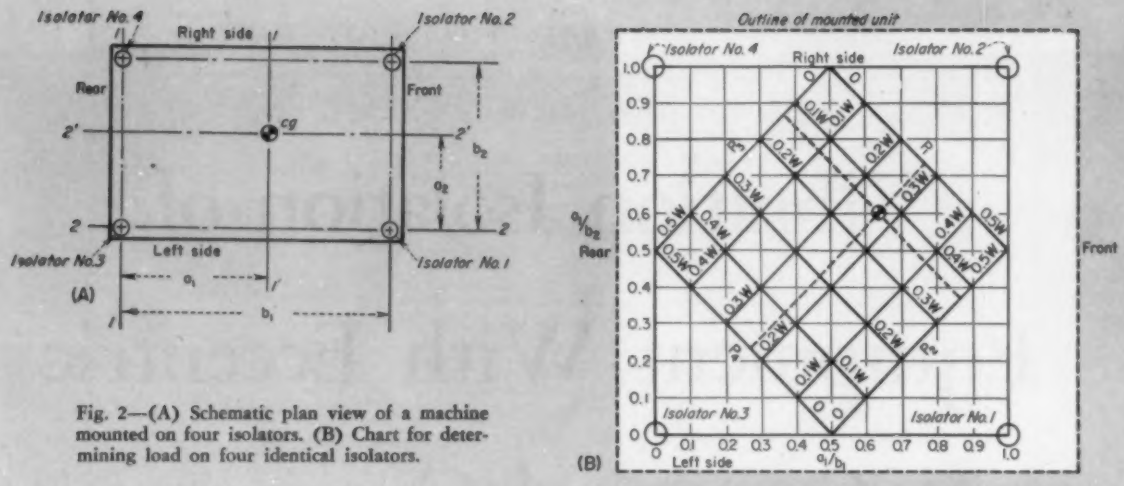


Fig. 2—(A) Schematic plan view of a machine mounted on four isolators. (B) Chart for determining load on four identical isolators.

supported on three isolators whose "b" dimensions are 20, 25 and 25 in., respectively. With all attachments made to cables and connectors, the "a" dimensions to the center-of-gravity are $a_1 = 5.2$, $a_2 = 8.75$ and $a_3 = 9.75$ inches. The loads supported by the three isolators are

$$P_1 = \frac{5.2}{20} \times 13.5 = 3.5$$

$$P_2 = \frac{8.75}{25} \times 13.5 = 4.7$$

$$P_3 = \frac{9.75}{25} \times 13.5 = \frac{5.3}{13.5} \text{ lb.}$$

Three isolators whose load ranges are each 3.5 to 5.3 lb can be used for this application. This represents a load range ratio of approximately 1.5 to 1.

FOUR-POINT MOUNTING (Four Identical Isolators)

A typical four point suspension using identical isolators is shown in Fig. 2(A). The load supported on each isolator depends not only on the weight and location of the center-of-gravity of the unit with all connectors attached, but also upon the stiffnesses of the four isolators. If the stiffnesses of all four isolators are identical, the load supported by each of the four isolators can be calculated.* The equations for the loads supported on the four isolators are as follows:

$$P_1 = \frac{1}{2}\left(\frac{a_1}{b_1} - \frac{a_2}{b_2} + \frac{1}{2}\right) W$$

$$P_2 = \frac{1}{2}\left(\frac{a_1}{b_1} + \frac{a_2}{b_2} - \frac{1}{2}\right) W \qquad (2)$$

$$P_3 = \frac{1}{2}\left(\frac{3}{2} - \frac{a_1}{b_1} + \frac{a_2}{b_2}\right) W$$

$$P_4 = \frac{1}{2}\left(\frac{a_2}{b_2} - \frac{a_1}{b_1} + \frac{1}{2}\right) W$$

Eqs (2) are plotted in Fig 2(B). Again, if P_1, P_2, P_3, and P_4 are all within the load range of the isolator considered, then four identical isolators can be used.

For example, if a 33 lb unit, whose center-of-gravity is 60 percent of the distance from the left-hand isolators to the right-hand isolators and 63 percent of the distance from the rear isolators to the front isolators, is mounted on four isolators of equal stiffness, the load on each will be determined by locating the point $\frac{a_1}{b_1} = 0.63$ and $\frac{a_2}{b_2} = 0.60$ on Fig. 2(B). Reading values from the four coordinates,

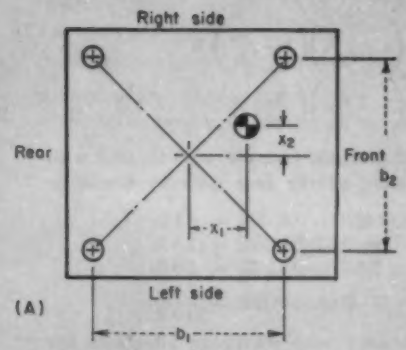
$$P_1 = 0.27 \times 33 = 8.9 \text{ lb}$$
$$P_2 = 0.37 \times 33 = 12.2 \text{ lb}$$
$$P_3 = 0.13 \times 33 = 4.3 \text{ lb}$$
$$P_4 = 0.23 \times 33 = 7.6 \text{ lb}$$

Thus, to use four isolators of equal stiffness the load range, over which each isolator will operate satisfactorily must be 4.3 to 12.2 lb (or a 3 to 1 load range).

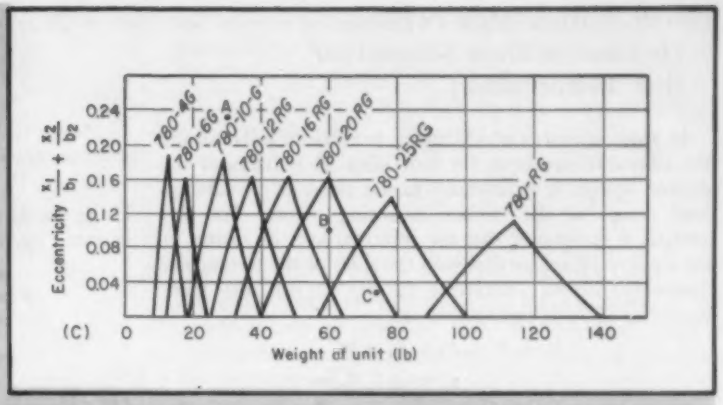
It is often desirable to know at a glance whether or not four identical isolators can be used in mounting a specific unit whose cg is known, and if so, what the load range of the isolators should be. The answers to these questions depend upon (a) the "eccentricity" of the cg with respect to the center of the mounting pattern, (b) the weight of the unit, and (c) the load range of the isolator. Fig. 3(a) shows a plan view of a unit supported on four isolators. The cg is displaced from the center of the mounting pattern by a distance x_1 in the fore-and-aft direction and a distance x_2 to the left or right. The eccentricity of the cg is defined as $\frac{x_1}{b_1} + \frac{x_2}{b_2}$. Fig. 3(b) shows a series of curves of allowable cg eccentricity vs. equipment weight for values of load range ratios that range from $1\frac{1}{4}$-to-1 up to 5-to-1.

In mounting the equipment of the previous example on four identical isolators, the load range and maximum rated load can be determined by locating the value of eccen-

* "Vibration and Shock Isolation", by Charles E. Crede, John Wiley & Sons, 1951. Eq. 4.97, page 199.

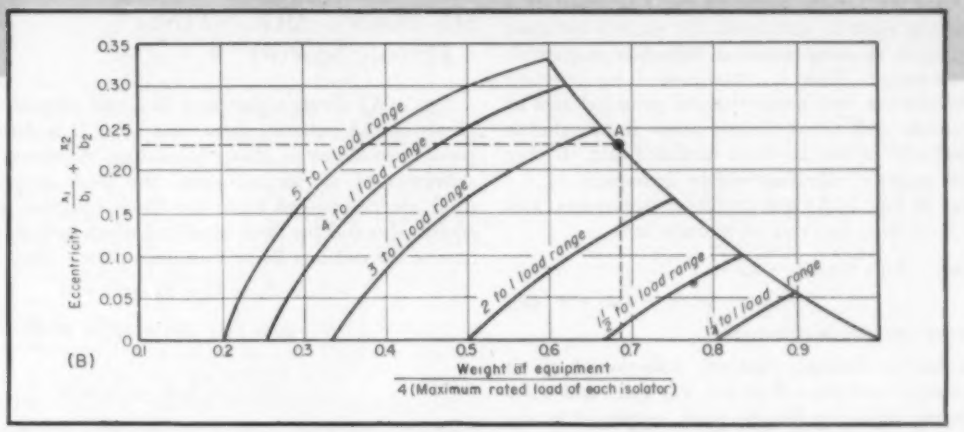


(A) Plan view of unit with eccentric cg supported by four isolators.



(C) Allowable eccentricity of center-of-gravity of unit supported on four identical type 780 Air-Damped Barrymounts.

Fig. 3


5 to 1 load range
4 to 1 load range
3 to 1 load range
2 to 1 load range
Eccentricity
Weight of equipment
4 (Maximum rated load of each isolator)
(B)

(B) Allowable eccentricity of center-of-gravity of unit supported on four identical isolators.

tricity on Fig. 3(B). This value is

$$e = \frac{x_1}{b_1} + \frac{x_2}{b_2} = 0.13 + 0.10 = 0.23$$

Point *A* represents the minimum load range needed to use four identical isolators and what that load range should be. Reading directly from the graph the ratio $\frac{W}{4P_{max}} = 0.685$, or the maximum rated load must be

$$P_{max} = \frac{W}{4 \times 0.685} = \frac{33}{4 \times 0.685} = 12.2 \text{ lb}$$

and the load range ratio should be at least 2.8 to 1. This gives a minimum rated load of 4.35 pounds. These values agree with the values obtained previously.

In applying commercially available or standard isolators, the load ranges are already established. The problem then resolves to determining whether or not one of the existing isolators can be used and, if so, which load range should be used. Fig 3(C) shows a series of curves of allowable cg eccentricity vs. equipment weight for units supported on four identical 780 Air Damped Barrymounts. Point *A* represents the previous example in which the cg eccentricity of the 33 lb. unit is beyond the limits of four mounts of the same load range. Regardless of which load range is selected, at least one of the isolators either would be overloaded or under-loaded. For any unit whose cg eccentricity falls outside the triangular patterns of all isolators of the desired design, different load ranges should be selected for the various isolators.

Point *B* represents a 60 lb equipment with a cg eccentricity of 0.10. Since this falls within the allowable cg eccentricity envelop of the type 780-20RG, four such isolators would provide the performance which they were designed to provide. In certain instances, the cg eccentricity will fall within the allowable eccentricity envelopes of more than one load range of isolator. An example of this would be a 73 lb unit with a cg eccentricity of 0.03, which falls within the envelopes of both the Type 780-20RG and the 780-25RG. While either load range would provide adequate isolation against vibration for this unit, it is usually desirable to select the isolator which would be capable of accommodating the greatest change in equipment weight and cg location before being either overloaded or under-loaded. This is represented by the distance of point *C* from the envelope curve of the isolator. Thus, the four Type 780-25RG mounts should be used.

FOUR-POINT MOUNTING (Isolator Stiffness Selected for Best Performance)

In applications in which the cg eccentricity falls outside the allowable envelopes for four identical isolators of the desired design, it is necessary to use isolators of different load ranges at the various mounting points. For this analysis it is assumed that the principal axes of inertia of the equipment are parallel with the sides of the rectangular mounting pattern. Referring to Fig. 2(A), the three equations of static equilibrium are:

$$\begin{aligned} P_1 + P_2 + P_3 + P_4 &= W \\ P_1 + P_2 &= W\frac{a_1}{b_1} \\ P_3 + P_4 &= W\frac{a_2}{b_2} \end{aligned} \qquad (3a)$$

To solve Eq (3a) for the loads on the four isolators a fourth condition must be introduced. To provide optimum vibration control, as many modes of vibration as possible must be decoupled. This is accomplished by selecting isolator stiffnesses in such a way that the principal axes of stiffness coincide with, or are directly below and parallel to the principal axes of inertia of the mounted unit. If they coincide, all modes of vibration will be decoupled.

Referring to Fig. 2(A) the condition that makes axes 1′–1′ and 2′–2′ principal axes of stiffness is:

$$K_1a_1(b_1 - a_1) - K_2(b_2 - a_2)(b_1 - a_1) - K_3a_2a_1 + K_4(b_2 - a_2)a_1 = 0 \qquad (3b)$$

where K = vertical stiffness of isolator.

Since it is further desirable that the deflection d of all isolators be equal and since $P = Kd$, Eqs (3a) and (3b) combine to the following for the loads supported by the four isolators:

$$\begin{aligned} P_1 &= \frac{a_1}{b_1}\left(1 - \frac{a_2}{b_2}\right)W \\ P_2 &= \left(\frac{a_1}{b_1}\right)\left(\frac{a_2}{b_2}\right)W \\ P_3 &= \left(1 - \frac{a_1}{b_1}\right)\left(1 - \frac{a_2}{b_2}\right)W \\ P_4 &= \left(1 - \frac{a_1}{b_1}\right)\left(\frac{a_2}{b_2}\right)W \end{aligned} \qquad (3c)$$

Using the data of the previous example, a 33 lb. unit with eccentric cg, the loading on the four isolators would be

$$\begin{aligned} P_1 &= (0.63)(1-0.6)(33) = 8.3 \text{ lb} \\ P_2 &= (0.63)(0.6)(33) = 12.5 \text{ lb} \\ P_3 &= (1-0.63)(1-0.6)(33) = 4.9 \text{ lb} \\ P_4 &= (1-0.63)(0.6)(33) = 7.3 \text{ lb} \\ &\qquad\qquad\qquad\qquad\quad 33.0 \text{ lb} \end{aligned}$$

For optimum performance with maximum allowance for changes in weight and cg, it is best to use isolators which will be loaded near the middle of their load ranges.

SIX-POINT MOUNTING (Evenly Spaced)

Fig. 4(A) shows a plan view of a unit supported on six evenly spaced isolators, three on a side. It is desirable, if possible, to utilize six identical isolators. Assuming that the stiffnesses of all six are equal, the loads supported on them are determined from the three equations of static equilibrium and the three equations which indicate that the tops of the isolators lie in a common plane. These are:

$$\begin{aligned} P_1 + P_2 + P_3 + P_4 + P_5 + P_6 &= W \\ P_1 + P_2 + \tfrac{1}{2}P_3 + \tfrac{1}{2}P_4 &= W\frac{a_1}{b_1} \\ P_3 + P_4 + P_6 &= W\frac{a_2}{b_2} \\ d_1 - d_3 &= d_5 - d_6 \\ d_2 - d_4 &= d_4 - d_6 \\ d_1 - d_2 &= d_5 - d_4 \end{aligned} \qquad (4a)$$

where d is the static deflection of the isolator.

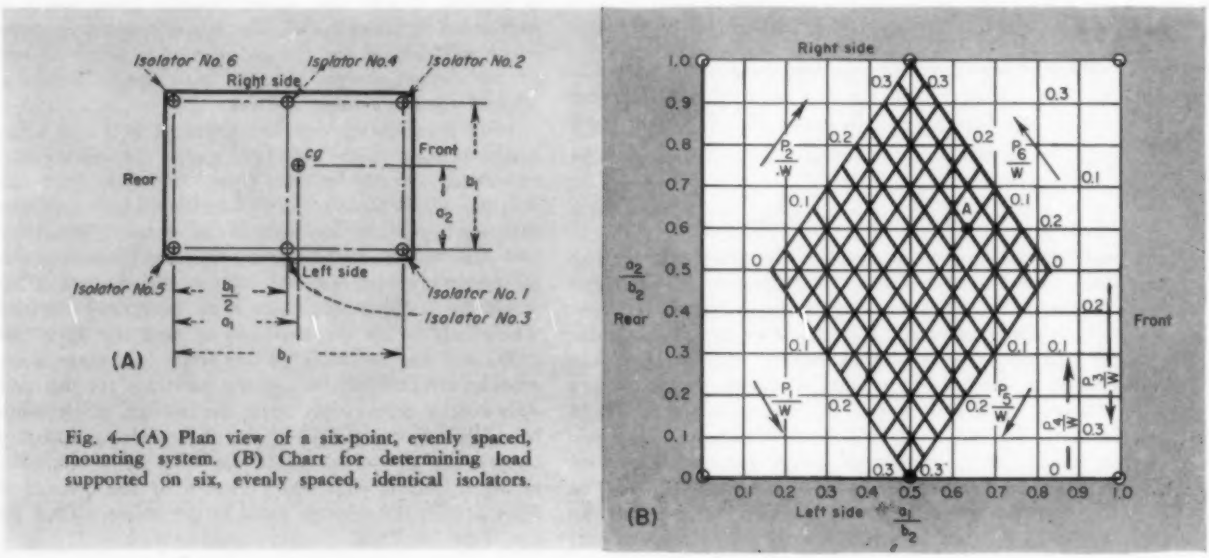


Fig. 4—(A) Plan view of a six-point, evenly spaced, mounting system. (B) Chart for determining load supported on six, evenly spaced, identical isolators.

Since the stiffnesses of all isolators are identical, $P_n = Kd_n$ and the last three equations can be written as:

$$\begin{aligned} P_1 - 2P_3 + P_5 &= 0 \\ P_2 - 2P_4 + P_6 &= 0 \\ P_1 - P_2 - P_3 + P_4 &= 0 \end{aligned} \tag{4b}$$

Solving Eqs (4a) and (4b) gives the following values for the loads supported on the six isolators:

$$\begin{aligned} P_1 &= \left(\frac{1}{12} + \frac{1}{2}\frac{a_1}{b_1} - \frac{1}{3}\frac{a_2}{b_2}\right) W \\ P_2 &= \left(-\frac{1}{4} + \frac{1}{2}\frac{a_1}{b_1} + \frac{1}{3}\frac{a_2}{b_2}\right) W \\ P_3 &= \frac{1}{3}\left(1 - \frac{a_2}{b_2}\right) W \\ P_4 &= \left(\frac{1}{3}\right)\left(\frac{a_2}{b_2}\right) W \\ P_5 &= \left(\frac{7}{12} - \frac{1}{2}\frac{a_1}{b_1} - \frac{1}{3}\frac{a_2}{b_2}\right) W \\ P_6 &= \left(\frac{1}{4} - \frac{1}{2}\frac{a_1}{b_1} + \frac{1}{3}\frac{a_2}{b_2}\right) W \end{aligned} \tag{4c}$$

Eqs (4a) are shown graphically in Fig. 4(B). If the unit of the previous example were mounted on six identical, evenly-spaced isolators, the cg would fall at point "A" in Fig. 4(B). The loads would then be:

$P_1 = 0.2 \times 33 = 6.6$ lb
$P_2 = 0.267 \times 33 = 8.8$ lb
$P_3 = 0.133 \times 33 = 4.4$ lb
$P_4 = 0.2 \times 33 = 6.6$ lb
$P_5 = 0.067 \times 33 = 2.2$ lb
$P_6 = 0.133 \times 33 = 4.4$ lb

Thus, the load range of the isolators must be 2.2 to 8.8 lb or 4 to 1 ratio.

In all applications using six evenly spaced isolators in which the required load range for six identical isolators does not fall within the rated load range of a desired isolator, isolators with different load ranges must be used at each mounting point so that each of them will be loaded within its own range. In addition to the three equations of static equilibrium, the deflections of all isolators should be equal, and it is assumed that the stiffnesses of the individual isolators will be varied uniformly from front to back, that is, $K_1 - K_3 = K_3 - K_5$ and $K_2 - K_4 = K_4 - K_6$. This leads to the following five equations:

$$\begin{aligned} P_1 + P_2 + P_3 + P_4 + P_5 + P_6 &= W \\ P_1 + P_2 + \frac{P_3}{2} + \frac{P_4}{2} &= W\frac{a_1}{b_1} \\ P_5 + P_6 &= W\frac{a_2}{b_2} \\ P_3 - P_4 &= P_4 - P_6 \\ P_1 - P_3 &= P_3 - P_5 \end{aligned} \tag{4d}$$

The sixth equation is determined by the coincidence of the principal axes of stiffness with the principal axes of inertia, thus decoupling the various modes of vibration. This is expressed as follows:

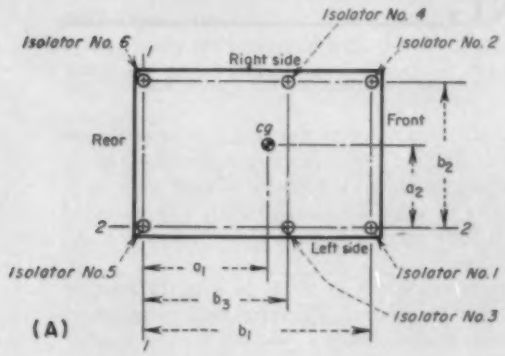
$$K_1\frac{a_2}{b_2}\left(1 - \frac{a_1}{b_1}\right) - K_2\left(1 - \frac{a_2}{b_2}\right)\left(1 - \frac{a_1}{b_1}\right) - K_3\frac{a_2}{b_2}\left(\frac{a_1}{b_1} - \frac{1}{2}\right) + K_4\left(1 - \frac{a_2}{b_2}\right)\left(\frac{a_1}{b_1} - \frac{1}{2}\right) - K_5\left(\frac{a_1}{b_1}\right)\left(\frac{a_2}{b_2}\right) + K_6\left(1 - \frac{a_2}{b_2}\right)\frac{a_1}{b_1} = 0 \tag{4e}$$

Combining Eqs 4(d) and 4(e) and realizing that

$$\frac{P_1}{K_1} = \frac{P_2}{K_2} = \frac{P_3}{K_3} \text{ etc.},$$

the expressions for loads on the six isolators are:

$$\begin{aligned} P_1 &= \left(1 - \frac{a_2}{b_2}\right)\left(\frac{a_1}{b_1} - \frac{1}{6}\right) W \\ P_2 &= \frac{a_2}{b_2}\left(\frac{a_1}{b_1} - \frac{1}{6}\right) W \\ P_3 &= \frac{1}{3}\left(1 - \frac{a_2}{b_2}\right) W \\ P_4 &= \frac{1}{3}\left(\frac{a_2}{b_2}\right) W \\ P_5 &= \left(1 - \frac{a_2}{b_2}\right)\left(\frac{5}{6} - \frac{a_1}{b_1}\right) W \\ P_6 &= \frac{a_2}{b_2}\left(\frac{5}{6} - \frac{a_1}{b_1}\right) W \end{aligned} \tag{4f}$$



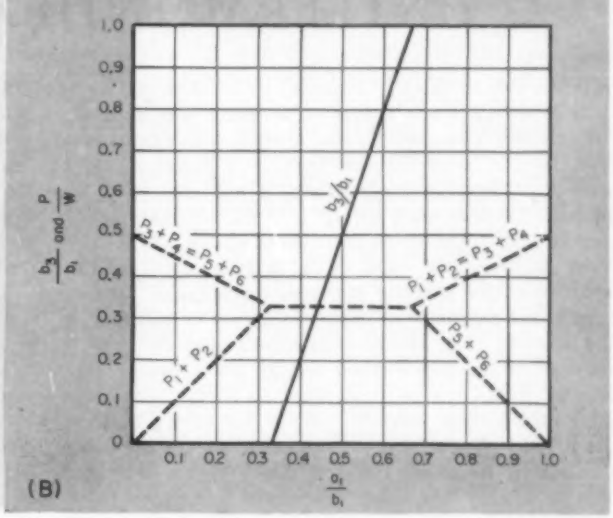


Fig. 5—(A) Plan view of a six-point mounting with optimum spacing. (B) Optimum location of middle pair of isolators and load on each pair of isolators in a six-point mounting system.

Referring again to the 33 lb. unit but supporting it on six evenly spaced isolators whose stiffnesses are selected for optimum performance, the following are the loads to be supported:

$$P_1 = (1 - 0.6)(0.63 - 0.167)(33) = 6.1 \text{ lb}$$
$$P_2 = (0.6)(0.63 - 0.167)(33) = 9.2 \text{ lb}$$
$$P_3 = \frac{(1 - 0.6)(33)}{3} = 4.4 \text{ lb}$$
$$P_4 = \frac{(0.6)(33)}{3} = 6.6 \text{ lb}$$
$$P_5 = (1 - 0.6)(0.833 - 0.63)(33) = 2.7 \text{ lb}$$
$$P_6 = 0.6(0.833 - 0.63)(33) = 4.0 \text{ lb}$$

SIX-POINT MOUNTING (Optimum Location)

Sometimes it is possible to locate the middle set of isolators for optimum distribution of load. In those cases, it is desirable to locate the middle set of isolators such that all six units are loaded as evenly as possible. Fig. 5(A) shows a machine in which the dimension b_3 can be selected for optimum loading. The most uniform loading that can be accomplished is represented by $P_1 + P_2 = P_3 + P_4 = P_5 + P_6 = \frac{W}{3}$. The loads supported by the six isolators and the distance b_3 can be determined by the equations of static equilibrium. Taking moments about axis 1–1;

$$\frac{b_3}{b_1} = 3\frac{a_1}{b_1} - 1 \qquad (5a)$$

This applies only when b_3 is in the range 0 to b_1, that is, when the middle isolators, Nos. 3 and 4 lie between the front and rear isolators, Nos. 1, 2, and 5, 6. The location a_1 of the cg for which this applies is in the range $1/3b_1$ to $2/3b_1$. If a_1 is less than $1/3b_1$. optimum loading occurs when $b_3 = 0$. Since the stiffness of isolators Nos. 3 and 4 equals that of Nos. 5 and 6, these isolators will be evenly loaded. That is,

$$P_3 + P_4 = P_5 + P_6 = \frac{1}{2}\left(1 - \frac{a_1}{b_1}\right)W \qquad (5b)$$

and

$$P_1 + P_2 = \left(\frac{a_1}{b_1}\right)(W)$$

When a_1 is greater than $1/3b_1$ optimum loading occurs when $b_3 = b_1$. By symmetry,

$$P_1 + P_3 = P_2 + P_4 = \frac{1}{2}\frac{a_1}{b_1}W, \text{ and} \qquad (5c)$$
$$P_5 + P_6 = \left(1 - \frac{a_1}{b_1}\right)W$$

Fig. 5(B) presents these conditions graphically.

For all cases in which the center-of-gravity falls within the middle one-third, the loads supported on all the right-hand isolators are equal and the load supported on all the left-hand isolators are equal, or

$$P_3 = P_4 = P_6 = \frac{W}{3}\frac{a_1}{b_1} \qquad (5d)$$
$$P_1 = P_2 = P_5 = \frac{W}{3}\left(1 - \frac{a_1}{b_1}\right)$$

Thus, if the 33 lb. unit were mounted on six isolators the optimum location is determined by Fig. 5(B) to be 0.89 b_1. From Eq (5d)

$$P_1 = P_2 = P_5 = \left(\frac{33}{3}\right)(1 - 0.6) = 4.4 \text{ lb}$$
$$P_3 = P_4 = P_6 = \left(\frac{33}{3}\right)(0.6) = 6.6 \text{ lb}$$

The load range required for such an application would be only $1\frac{1}{2}$ to 1 as compared to 4 to 1 required when the isolators were evenly spaced.

When the cg lies in the extreme regions (a_1 less than $1/b_1$ or greater than $2/3b_1$) the analysis for the four point mounting as outlined above should be used, dividing the load at each point by the number of isolators at that point.

UNITERM INDEXING

ASTIA—Armed Services Technical Information Agency—is field testing a new system of indexing and retrieving information. The new technique, developed by Documentation, Inc., is called Uniterm Coordinate Indexing. As a method of filing technical reports, it may save up to 90 percent of catalog space and up to 75 percent of cataloging time currently used by the government agency.

In this system all words in the language are treated as equal terms for indexing purposes, regardless of parts of speech, and are joined as phrases in answer to questions by the searcher. For example, all information on guns is recorded by its identification number on a catalog card labeled "guns;" and all information on aircraft is recorded on a card labeled "aircraft." When identifying numbers are found to be common to both cards, the corresponding information pertains to "aircraft guns." Still a third card may be labeled "aircooled." Numbers in common to all three cards indicate information on "aircooled aircraft guns."

With the old system, when describing information on "aircooled aircraft guns", the indexer faces the choice of six forms of catalog entry: (1) aircooled aircraft guns; (2) aircraft guns; (3) guns, aircraft-aircooled; (4) aircooled guns, aircraft; (5) guns, aircooled, aircraft; and (6) aircraft-aircooled guns.

The cataloger might use all six to be sure the searcher would find what he wanted. The intentional formlessness of the Uniterm System makes it possible for the searcher to consult the catalog in any way, and at the same time gives him assurance of a complete search at once without having to refer to a number of different places in the catalog. The indexer can effect a depth of analysis hitherto impractical in far less time than even a shallow analysis can be accomplished by conventional means.

WANTED:

Engineers for Atomic Energy

THE NUMBER OF ENGINEERING EMPLOYEES in atomic energy work has skyrocketed in the past five years; it's scheduled for another big boost in the next ten. In 1948 there were less than 3,000 engineers working for the Atomic Energy Commission; last year, AEC reported 7,100 physical scientists and 6,200 engineers permanently employed in atomic installations. This does not include the hundreds more involved, on a temporary basis, in the construction of new facilities.

AEC plans to add 2,500 more engineers and an equal number of scientists by the end of 1956. These additions are based on present projects; they preclude a civilian atomic energy industry. When this is also considered, 1956 needs for new engineering talent must be boosted by at least an additional thousand. One very optimistic estimate predicts that by 1956 the civilian atomic energy industry will need 10,000 engineers.

Another source that will continue to make demands for atomic engineers is the military. Because of normal attrition, the Armed Services will need almost 350 scientists and engineers for power and weapons work every year.

Engineer's work in the atomic energy program ranges broadly. Some are associated in the procurement, purification or preparation of nuclear fuel. Others work on the design, implementation or operation of nuclear reactors. Many are concerned with the use of the reactor for producing power and radioactive isotopes. And still many others are needed for medical, physical or industrial research.

Trying to meet this varied need, educators have drawn up a list of different jobs that engineers and scientists perform in the nuclear power field. The problem is to determine the best way of training college students and graduate engineers to fill these positions. There are two theories: (1) Train "nuclear engineers" ir universities; or (2) train engineers well-grounded in fundamentals, allowing them to learn the aspects of nuclear engineering in graduate school or on the job.

At an industrial installation like Westinghouse Electric Corporation's Atomic Power Division, scientists like the latter approach. They want engineers of conventional classifications, but better schooled in the fundamentals of physics, chemistry, particularly mathematics, engineering mechanics and materials. If college curricula are to be modified for the atmoic energy era, veterans of atomic work want to see an added emphasis on basic subjects rather than the introduction of new nuclear topics.

As Dr. W. E. Shoupp put it:

"It's our general feeling that the universities should stress fundamentals in their courses, and should teach students to be good engineers in their chosen fields. The atomic energy business can come later, either in graduate work or on the job. Here we require from new employees very little in the way of specialized training—we would rather have a man whose training has placed strong emphasis on the fundamental aspects of engineering. If a student is well-trained in those, he can pick up the atomic energy aspects at any time. However, an atomic energy college curriculum involving selected standard courses that stress the development of basic knowledge in physics, mathematics, heat transfer, chemistry and mechanical engineering would be of great value."

Working on the Navy's submarine reactor has given these Westinghouse scientists an insight into what is needed in new personnel. For instance, a mechanical engineer should have a strong background in thermodynamics—particularly heat transfer. The electrical engineer should be well versed in power circuitry. All should be able to cope with the "hardware" aspects of their fields—selecting necessary standard pieces of apparatus.

Atomic energy may force a shift of emphasis on college curricula, in accordance with the law of supply and demand. Today's needs—and those of the next five years—will be heaviest in the fields of metallurgy, physics and heat transfer. The severest shortage is metallurgists, particularly those holding doctorates with specialization in metallurgy. Last year there were only a handful of such graduates in the United States.

Nuclear power generation dictates another requirement: engineers better trained in the fundamentals of their specialization. This will become more significant as the atom is proven an economical source of power.

There is a third, but by no means least important, characteristic for technically trained personnel: an interest in research and the urge to "try this out." The development-type engineer is required today because both the AEC and private companies are still building one-of-a-kind apparatus. At present there is a limited demand for production knowledge; in ten years the picture will undoubtedly change with a stronger emphasis on production phases.

DESIGN FEATURES

Magnetic Memory Goes Commercial

With the recent installation of the Speed Tally System in a mid-western mail order house, high speed electronic computing machine art has taken the latest step in the commercialized application of automatic information-processing systems. Developed by the Engineering Research Associates Division of Remington-Rand Inc., the new system has been designed expressly for rapid tallying and inventory record keeping. Performance-wise, Speed Tally is capable of keeping three categories of tallies for each of 13,000 items with complete totals for each of the items automatically printed out of the system in 3 hours. Applied to its specific task of catalog order processing, the system has an input of approximately 75,000 order-lines per day with 10 order clerks.

Basically, the system mechanizes the tally operation by performing the search for the appropriate item record, totalling and recording the tally. Information consisting of a quantity and identifying item number, is entered into the system from any of 10 identical keyboard-indicator desk sets. As soon as the last digit of the 5 digit item number has been entered, the central drum memory unit automatically connects itself with the controlling keyboard and stores the quantity and item number in input registers. The registers locate the specified area on the drum, read the quantity previously there into an arithmetic register, add or subtract the quantity from the keyboard, and return the adjusted total to the proper place on the drum. Total time consumed for the entire operation is less than 0.4 seconds.

Heart of the Speed Tally System which essentially consists of keyboard-indicator sets, punched tape reader-punch, memory storage drum and output printer is the magnetic drum unit. Information is stored serially on the drum in 130 tracks of 3,600 bits each (12 bits being required for the three digit total). Information is recorded or read by means of 130 read-record magnetic heads, one for each track.

The drum is considered to be divided into 5 sections where particular operations take place. Thus, during each drum rotation period these operations occur: (1) readout old quantity from drum; (2) and (3) add or subtract quantity entered; (4) idle; (5) new total entered on controlling keyboard; and (6) enter new quantity on drum at position from which it was readout. Basic tallying cycle is 1-1/5 drum revolutions.

TERMS USED IN DESCRIPTION OF SYSTEM

Address—Coordinates of one or more bits on the magnetic drum surface in terms of angular and axial positions.

Allotter—A ten-position rotary stepping switch connecting the keyboards to central equipment.

Bit—The unit of storage, a magnetized dipole having either of two polarity orientations in the lateral direction on the magnetic drum.

Cell—A rectangular area on the drum surface, many of which divide the drum track along its circumference.

Interlace—A system used to prevent recording of bits of a certain quantity in adjacent cells. Avoids necessity of operating equipment at rapid rate.

Magnetic Head—Transducing mechanism for reading and writing.

Stop-Section—A seven-stage mechanical storage register within a keyboard.

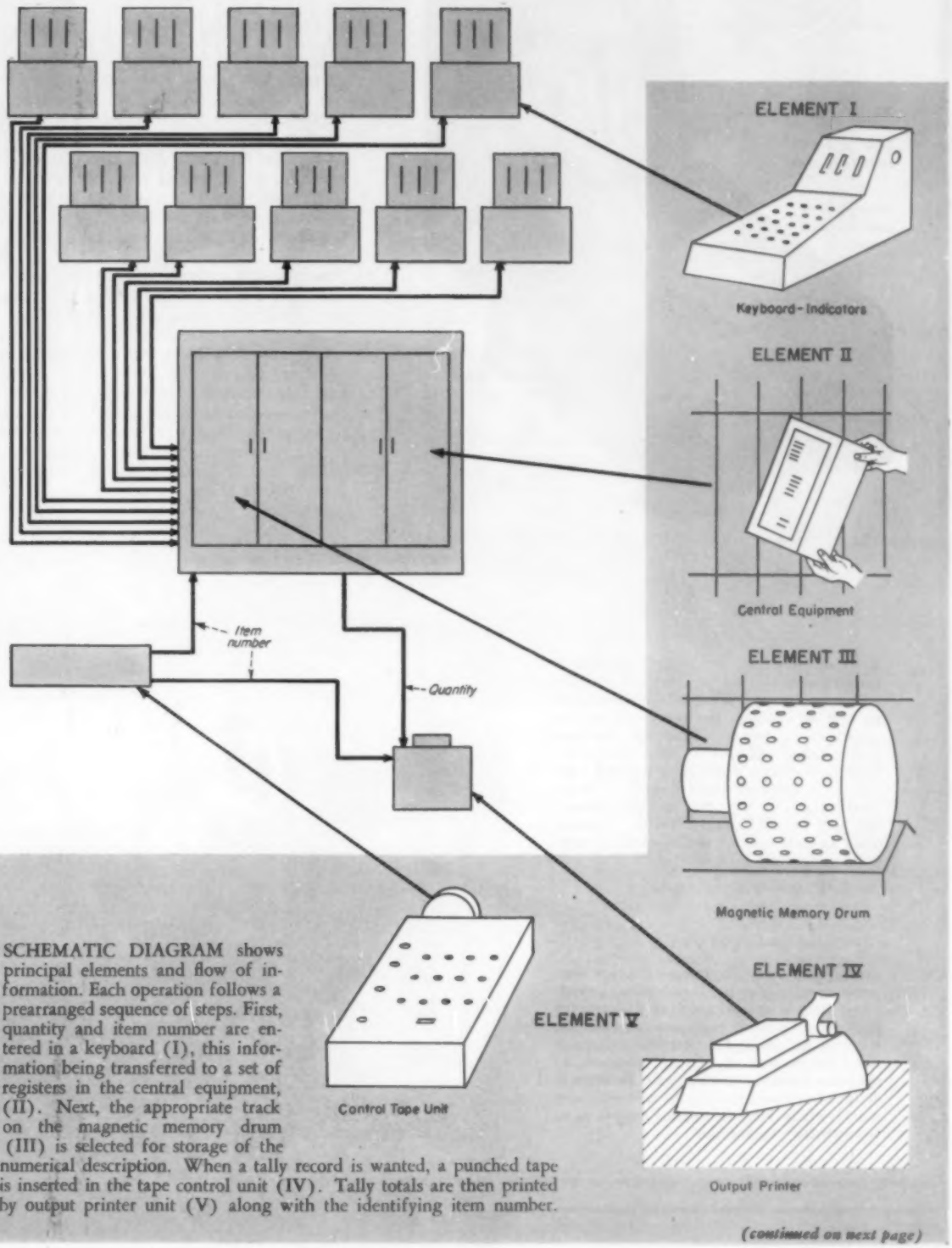
Track—A portion of the magnetic drum surface which sweeps beneath the magnetic head.

(a) Control Track—Consists of five marks, each mark designating beginning of one of five sectors of drum surface.

(b) Mark Track—A single reference mark used to designate beginning of timing track, its locating determining instant at which count of timing pulses start.

(c) Timing Track—Consists of a continuous series of marks completely encircling the magnetic storage drum.

IN NEW PRODUCTS



SCHEMATIC DIAGRAM shows principal elements and flow of information. Each operation follows a prearranged sequence of steps. First, quantity and item number are entered in a keyboard (I), this information being transferred to a set of registers in the central equipment, (II). Next, the appropriate track on the magnetic memory drum (III) is selected for storage of the numerical description. When a tally record is wanted, a punched tape is inserted in the tape control unit (IV). Tally totals are then printed by output printer unit (V) along with the identifying item number.

(continued on next page)

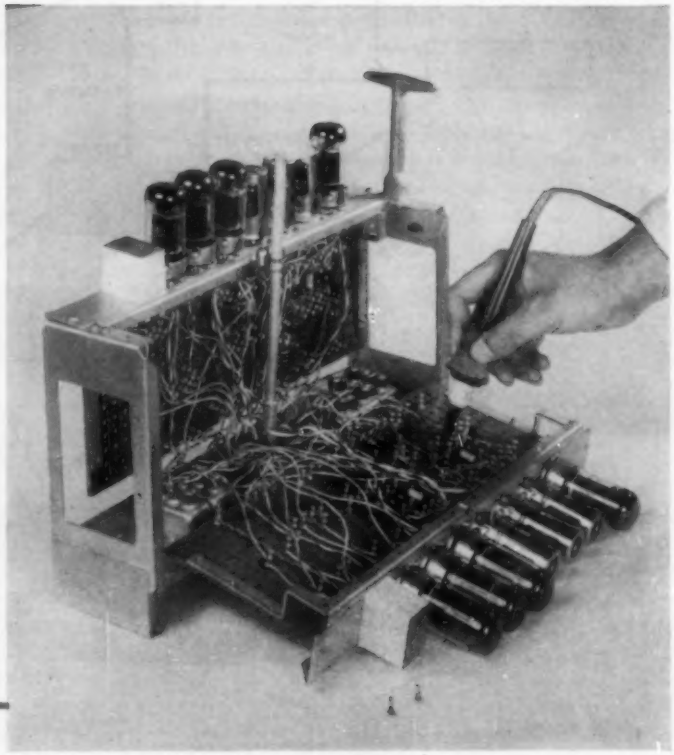
Speed Tally System (continued)

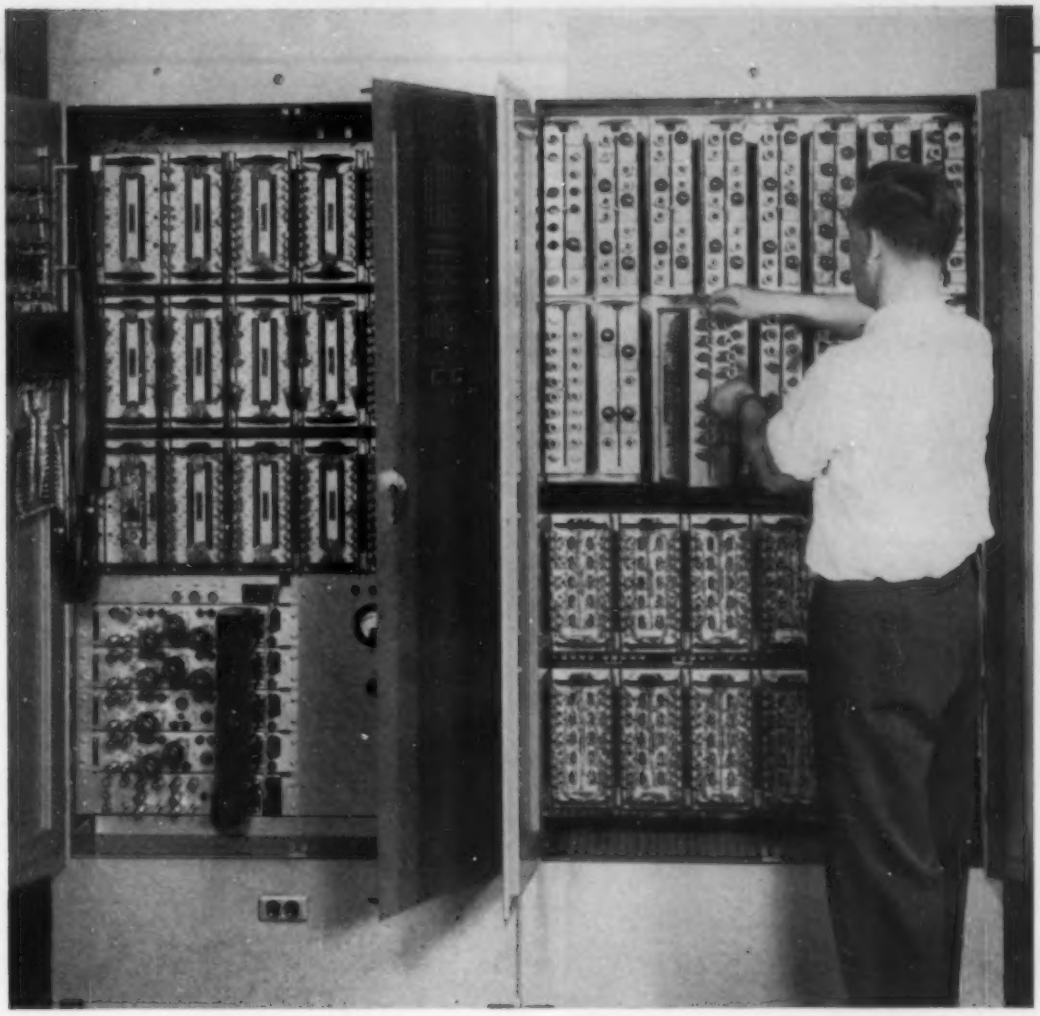
ELEMENT I

Speed tally operation begins with the entry of quantity and related item number in a keyboard. Translation of key depression into electrical signals is accomplished by a switch which senses the position of a stop-section within the keyboard. Each time a key is depressed, one element of the stop-section is set corresponding to the key number, and the stop-section moves one column to the left. When the last digit of the item number is entered—the category key being set to one of three positions—the seventh column element of the stop-section is set and the sensing switch moves into position to sense all 7 columns. At the same instant, a signal is sent to the central equipment "telling" it that a completed entry is ready for transfer. During this period of transfer, approximately 0.4 sec, all other keyboards are excluded. After internal processing of the information with adjusted total entered on the magnetic drum, a reset signal is returned to the controlling keyboard disconnecting it from the central equipment.

Keyboards are used to translate mechanical entry of quantity, item number and category into electrical signals. Capable of subtraction as well as addition, the keyboards are designed for a two-digit quantity, five-digit item number and one of three categories. Quantity indicator lights show adjusted tally total after keyboard entry. Quantity full indicator lights up when adjusted tally exceeds 999, and invalid indicator notifies operator when an item number not assigned to magnetic storage has been entered.

Central equipment features unit chassis electronic construction for maintenance accessibility. Plug-in spares speed up maintenance procedure. To insure performance reliability, a special test problem is fed into equipment daily, before start of tallying operation, to pin-point potential trouble spots. Problem is designed to lower margins of safety thereby quickly earmarking the vacuum tube or tubes approaching "end-of-life."





ELEMENT II

Completed entry signal from keyboard is sent to an allotter in the central equipment. The allotter steps to the signalling keyboard's contacts and stops, energizing the proper relays to connect the keyboard to the equipment. When connected, the keyboard transfers its entry information to a set of registers which "translates" the data and then selects the appropriate track on the magnetic drum for storage of incoming quantity. The existing tally total from the drum is read into a quantity register. New total is calculated and displayed on the counter lamps at the keyboard. During this operation, allotter remains in its connected position until a keyboard reset signal is issued by the central equipment, disconnecting the controlling keyboard from allotter. Reset signal also disconnects keyboard for "invalid number" or "quantity full" alarm. If no other keyboard needs servicing, the allotter remains in its last position.

Central equipment contains a set of registers which receives from the keyboard the seven digit number specifying quantity, item and signal identifying the category. Registers feed other electronic components which select the appropriate track of the magnetic drum, also specifying angular position on the track that is to "read-out" its tally total. Housed in the central cabinet, the dimensions of which are 9½ ft long, 2½ ft wide and 6½ ft high, are the drum, associated reading, writing and locating circuits, input keyboard scanner and regulated power supplies. Power requirements are 220 v, 3 phase; consumption is 4 KW. Because of dangerous potentials, cabinet doors are interlocked to protect personnel.

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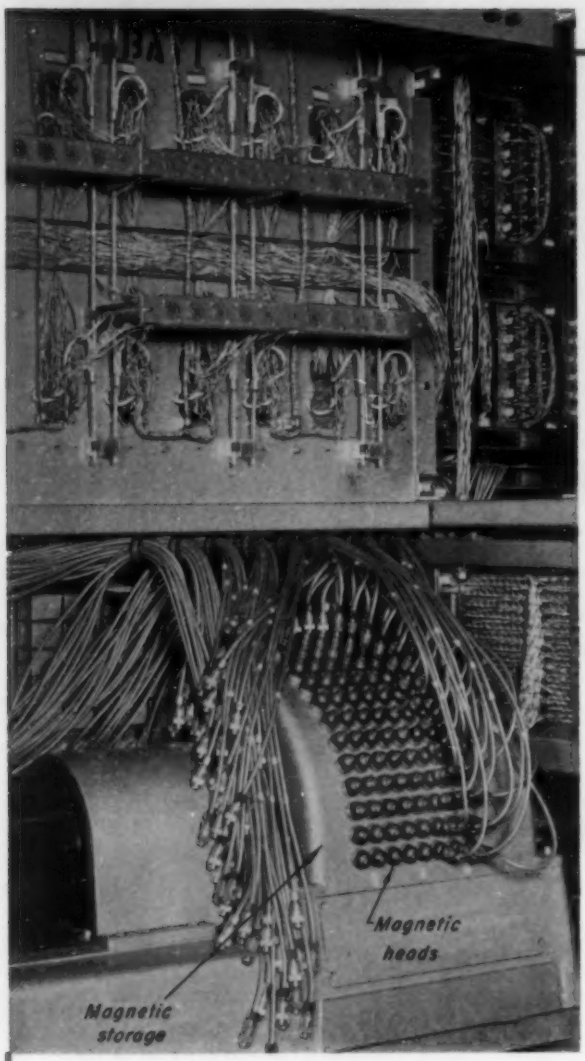
Speed Tally System (continued)

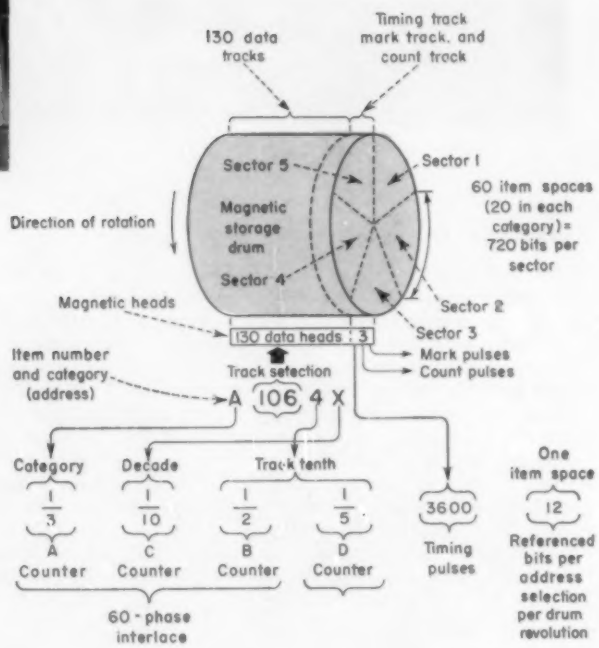


A continuously rotating cylinder traveling at a peripheral velocity of 1,590 in. per sec, magnetic drum has 16 tracks per in. of length and 68 cells per in. of circumference. At scanning rate of 107,000 cells per sec, each cell period is about 9 milliseconds long, during some fraction of which a cell and magnetic head are properly positioned either to record new data or read previously stored information. To record, magnetic head produces a fringing flux of sufficient magnitude to form magnetized dipoles in the drum surface. When used for reading, the magnetic head, there are 130, receives from these dipoles a changing flux which by its form identifies the value of the stored bit.

ELEMENT III

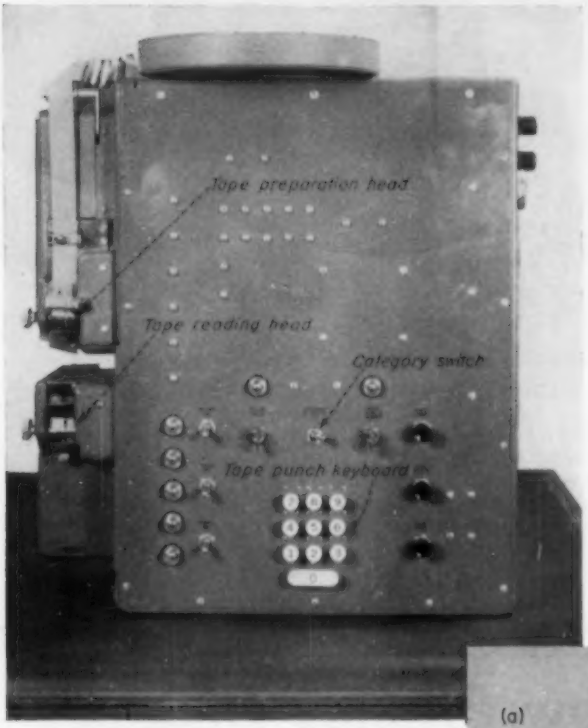
Sketch below illustrates the principles employed in performing the location and selection of one specific tally record from the 39,000 present on the drum surface. In the center of the figure in boldface note the catalog number and category, A1064X. The category "A" in this instance merely identifies which of three tally totals—arbitrarily referred to as "A", "B" or "C"—is to be located. The remaining 5 digits, 1064X, describe a particular item number from among the 13,000. The "X" is used to signify any value, zero through nine. The higher order three digits, 106, perform two operations. First, they select one of the 130 magnetic heads and thereby reduce the 39,000 candidates to 100 sets of 3. The remaining two digits, 4X, then specify a particular set from these 100. Because of the random number system used, the track selecting digits also modify the value of the 10's digit to preclude the existence of duplicate values in any one track.

Since the timing track contains 3600 discrete bit positions, the consecutive action of the category and item number digits reduces these by $\frac{1}{3}$, $\frac{1}{10}$, $\frac{1}{2}$ and $\frac{1}{5}$ leaving only 12 bit locations eligible for controlling the output of the reading amplifier into the quantity register. Selection is achieved by a timing pulse count-down arrangement.



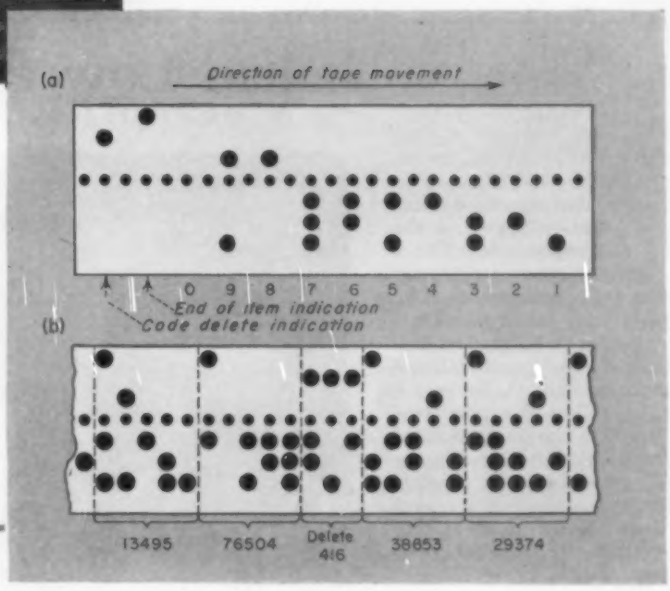
ELEMENT IV (below)

Tape Control Unit performs two functions: It both prepares and reads a coded perforated tape which schedules the item numbers and category for which tally totals are desired. Output of this unit is to the central equipment, tape decoding being translated into electrical signals that give the item addresses on the magnetic drum for subsequent quantity reading.



ELEMENT V (above)

A printed tape showing item number and its associated tally total in one category can be produced by the output printer when desired. Being a receiving type machine, it is actuated by a perforated tape inserted in the tape control unit. Item number and quantity registers in the central equipment send the electrical signals to energize the printer mechanism. Should an invalid item number be signalled from the control tape unit, the tape printer will stop, until cleared by the tape control unit. Speed of the output printer which is a standard unit is 75 lines of tally totals per minute.



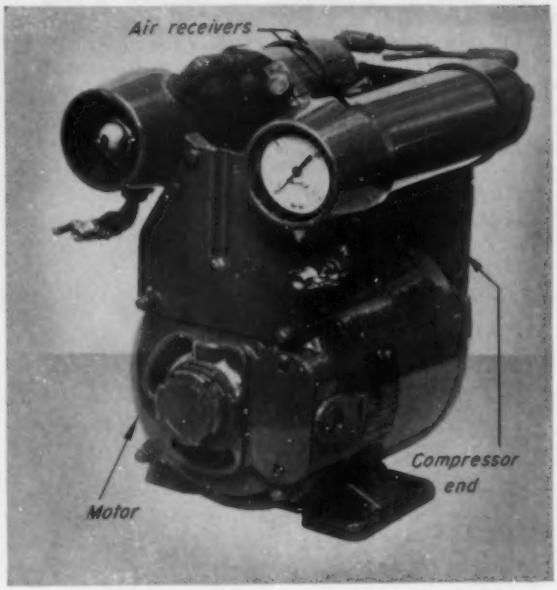
At right are shown **the tape coding used (a) and a portion of a typical output control tape (b). The tape carries only the item number for which a tally is wanted; category designation is made by a 3-position switch on the control unit. The tapes are prepared by simply punching in item numbers on the unit keyboard. They can be readily prepared to produce reports required such as specific products activity, warehouse inventory, total order volume.**

British Air Compressor Uses

A diaphragm-type air compressor, recently developed by Hymatic Engineering Co., Ltd., Redditch, Worcestershire, England, for low capacity applications using pressures up to 30 psi, makes use of a flat rubber fabric disk as the inlet valve and a synthetic rubber O-ring as the delivery valve. This design not only simplifies the valving mechanism (thereby reducing cost), but it also assures quiet operation.

The circular disk forming the inlet valve is secured at its center to a valve plate held against the diaphragm and head of the connecting rod. As the diaphragm is pulled downward on the intake stroke, air in the crankcase passes through coinciding holes in the connecting rod head, diaphragm and valve plate, flowing under the flexible valve and into the compression chamber. Upward movement of the diaphragm then forces the disk back against the valve plate sealing the intake ports.

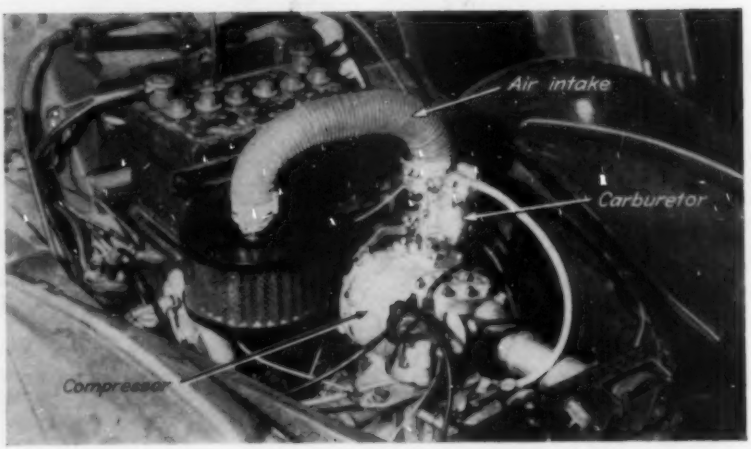
The delivery valve is an O-ring that fits in a Vee groove machined around the head of the compression chamber cover. When the diaphragm moves upward, air trapped in the compression chamber is forced through holes in the cover, which are connected to the apex of the circular groove. Unseating of the O-ring by the compressed air then permits delivery of the air to the receivers. Besides acting as a positive seal, the ring offers only a negligible amount of back pressure.



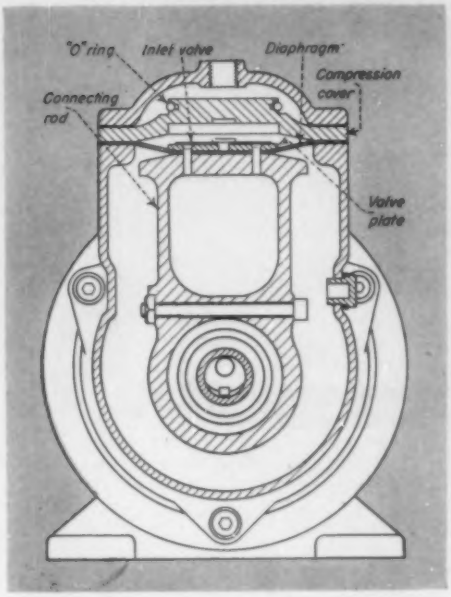
LIGHTWEIGHT COMPRESSOR is driven by a 1/6 hp electric motor and discharges into twin air receivers mounted on the top of the unit. Output pressure can be controlled up to 30 psi, with the pressure differential between cut-in and cut-out also variable. Use of a multi-ply diaphragm to replace the usual piston and cylinder eliminates presence of oil in the compression chamber of the new compressor.

Italian Low Pressure Injector

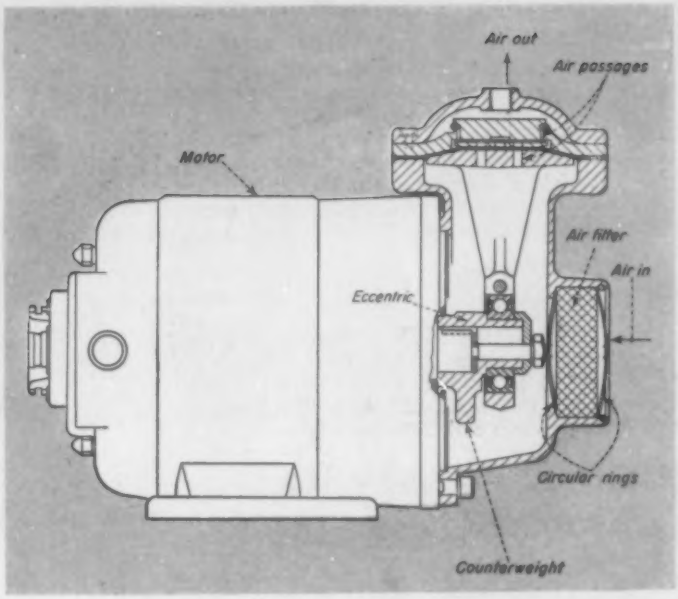
EUROPEAN APPROACH to increasing the volumetric efficiency of internal combustion engines, particularly at low rpm, is shown in the volumetric compressor installed on a "Dyna Panhard" sports car engine. A product of Italmeccanica Co., Turin, Italy, this essentially Roots vane type blower is designed to supply a steady flow of gas-air mixture at constant pressures to the intake manifold, regardless of engine revolutions. One big advantage claimed is installation without alterations to engine. The manufacturer also points out that when installed on a typical 30 ton tank, the compressor reduces the weight-to-power ratio by almost 25 percent.



Unusual Valving Arrangement

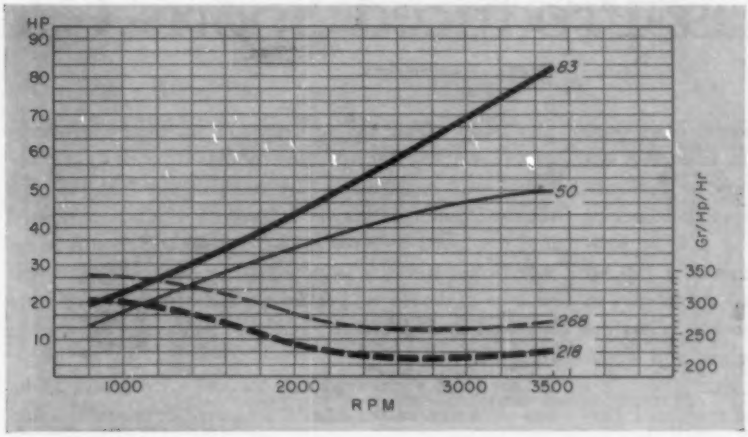


VIEW of compressor end shows mushroom-shaped head of the connecting rod. Machined to match the shape of the bottom side of the compression chamber cover, the head carries the inlet valve and valve plate, and is secured to the diaphragm. Since no working parts are in rubbing contact, lubrication is not required.



AIR ENTERS CRANKCASE through a filter housed at the compressor end of the unit. The connecting rod is fitted over a sealed grease packed ball bearing which is carried on a counterweighted eccentric keyed to the motor shaft. Side view of compressor shows connecting rod at the top of the compression stroke, the compressed air being forced under the O-ring into the receivers. Since the lift of the ring is small, a long service life is said to be assured.

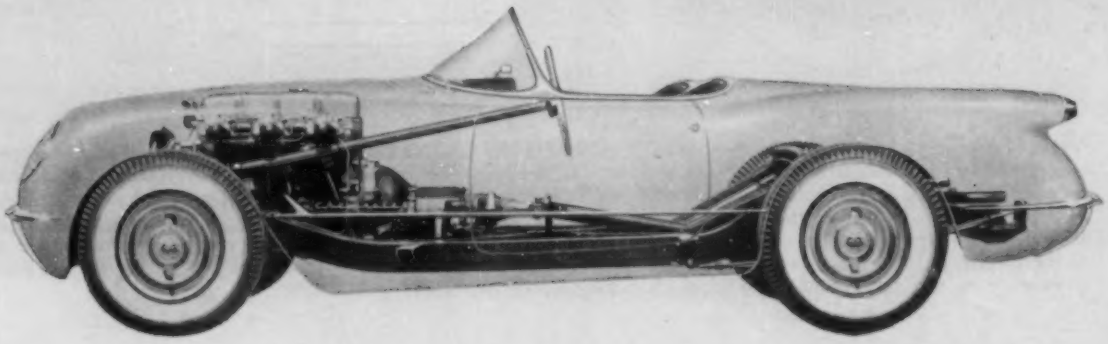
Improves Engine Efficiency



POWER and specific fuel consumption curves for a Ford-Vedette engine of 2,158 cc displacement, with and without volumetric compression. The solid curves represent hp vs rpm, heavy line denoting compressor installation. At the bottom of the chart is shown the plot of gr/hp/hr against rpm with the heavy dotted curve representing specific fuel consumption when the engine is equipped with a volumetric compressor. With compressor, power is increased 86 percent and fuel consumption about 24 percent at full speed. Note that both the increase in hp and reduction in specific fuel consumption is constant over the entire speed range.

VIEWED FROM THE FRONT, the Corvette has a low, wide appearance, the radiator grille being designed to permit cooling air to enter the radiator core. Headlights are recessed in the sloping fenders and protected by removable chrome wire mesh screens. Weight is distributed about 53 percent in the front and 47 percent in the rear.

LOW SILHOUETTE of Corvette is illustrated by phantom view. Overall length is 167.25 in.; overall width, 72.24 in.; and height over windshield, 48 in. Total weight of the car is only 2,900 pounds.

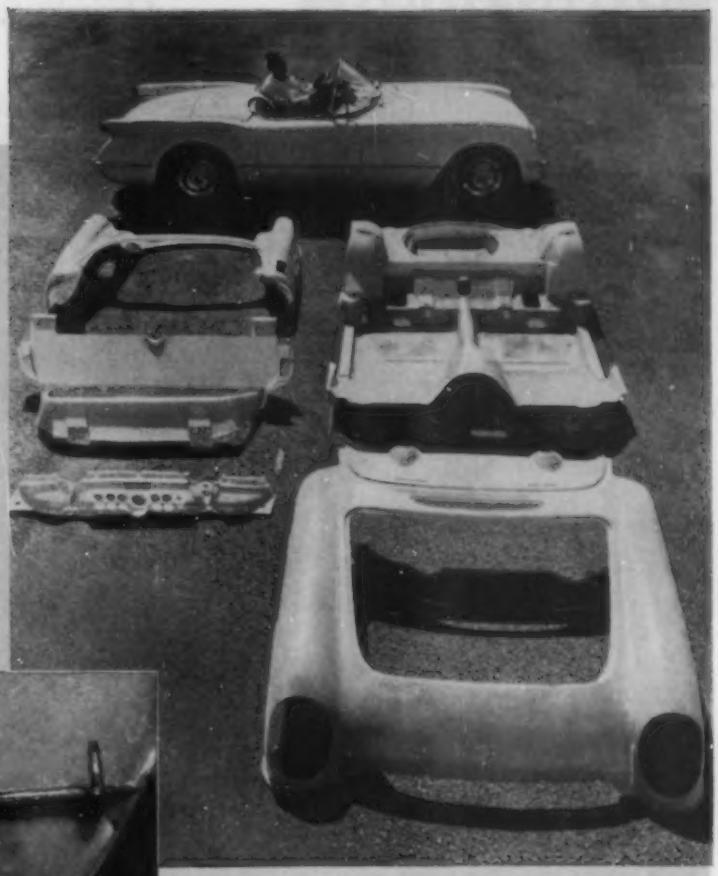


Mass-Produced Sports Car

In bringing out—on a production model basis—one of America's first plastic body sports cars, Chevrolet has made no compromise with styling, luxury or performance. Highlighted by its contrasting brilliant red interior and white body, and styled to emphasize a wide, low-slung appearance, the new Corvette boasts of a 150 hp engine, automatic transmission and good roadability at high speeds. And, unlike most sports models, it has the standard car's rear-located luggage locker, and doors wide enough to insure easy entrance or exit.

Biggest feature of the Corvette is the molded Fiberglas body which weighs only 411 lb, little more than half that of the Bel Air convertible body with its conventional steel construction. By reducing the body weight, the car's center of gravity is lowered which is translated into improved stability at high speeds and in cornering. Additional stability is obtained by mounting the rear springs outboard of the frame, increasing the distance between spring centers, and by inclining the springs forward.

Low (6 in.) ground clearance and a wheelbase 13 in. less than that of the standard Chevrolet required adop-



MOLDED FIBERGLAS BODY. Produced initially by the bag method, components will eventually be made by matched metal or epoxy dies. Body strength equal to that of conventional steel construction is obtained by 7 alternate layers of resin and Fiberglas, 4 of resin and 3 of matting. The plastic material, it is claimed, is unaffected by temperature extremes and has good moisture resistance. Besides being rust proof, the material is not affected by oil, grease or most chemicals.

MAJOR BODY SEAMS are both chemically and mechanically bonded. Spring-loaded clamps hold the seams together. Then flanges are drilled and riveted.

With Custom Features

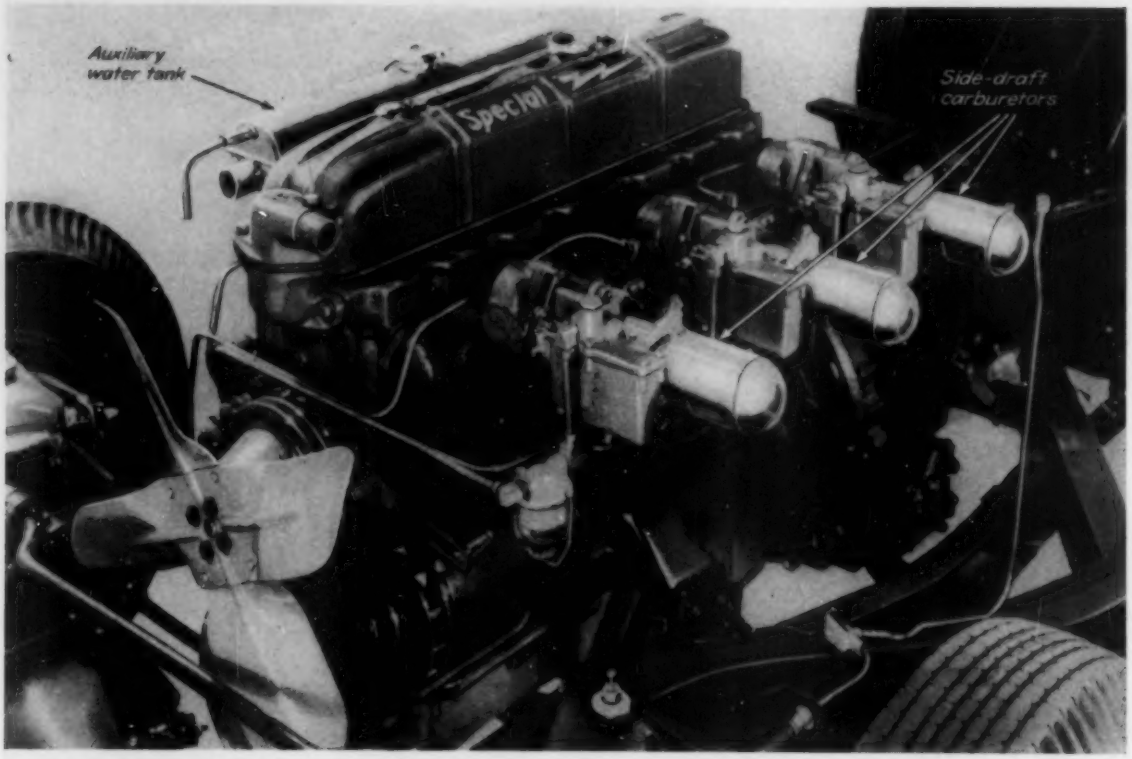
tion of the Hotchkiss drive. Otherwise, the torque tube needed would not be long enough to prevent excessive changes in wheel speed when traveling over rough roads.

To meet the flashy performance demanded by the sports car enthusiast, the 1953 Blue Flame engine has been upped from 115 hp at 3,600 rpm to 150 hp at 4,200 rpm, the torque being raised to 223 ft-lb at 2,400 rpm. This additional power was obtained by increasing the compression ratio to 8:1, adopting triple-side-draft carburetion and a high lift cam shaft plus a dual exhaust arrangement. Other engine modifications include changes in the coil and distributor to make increased secondary voltage available at high speeds.

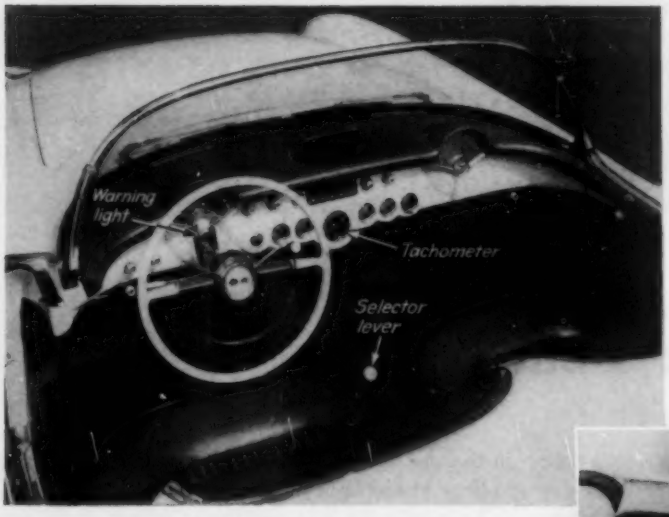
To handle the increased power output of the engine, the 1953 Powerglide transmission was also modified. Oil pressure was raised, and the shift valve was redesigned.

On the interior, passenger comfort is combined with functional design. The seats are form fitting, foam rubber padding and soft coil springs adding to riding ease. Practically the only concessions to true sports car design are the vertically mounted steering wheel and engine revolution tachometer. *(continued on next page)*

Chevrolet Sports Car (continued)

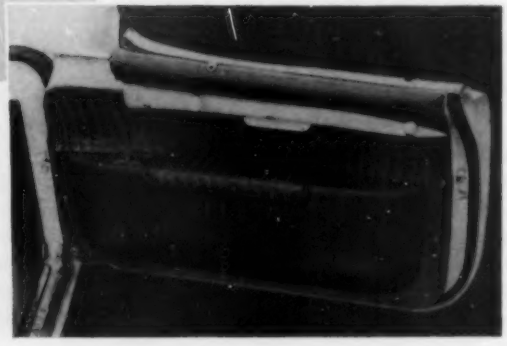


CAST ALUMINUM intake manifold has three separate ports for mounting of side-draft carburetors. Note auxiliary water tank. Located slightly above top of cylinder head, tank retains a reserve supply of water to keep motor circulating system submerged. Additional cooling water, when required, is added to auxiliary tank rather than radiator.

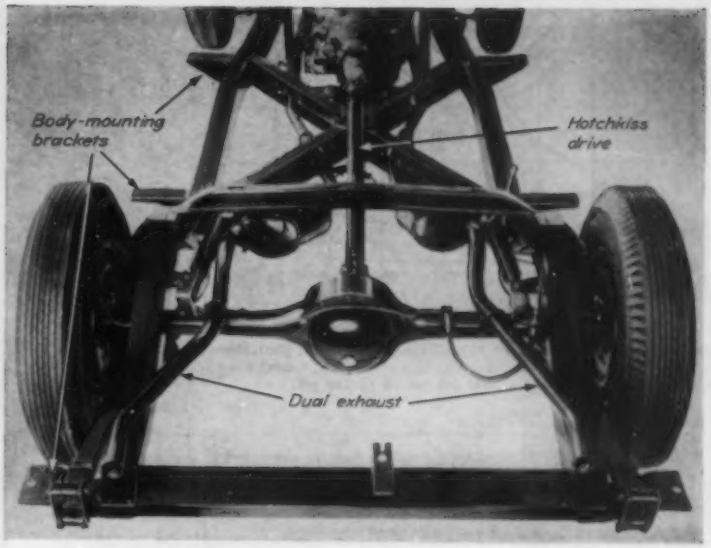


COCKPIT VIEW shows location of transmission selector lever next to driver's seat. A concession to sports car design, lever had to be taken off steering column to permit installation of side-draft carburetors. Instruments are similar to Chevrolet units, the engine revolution tachometer being the only extra. Borrowing an item from luxury cars, Corvette has warning light to indicate when parking brake and ignition key are both "on."

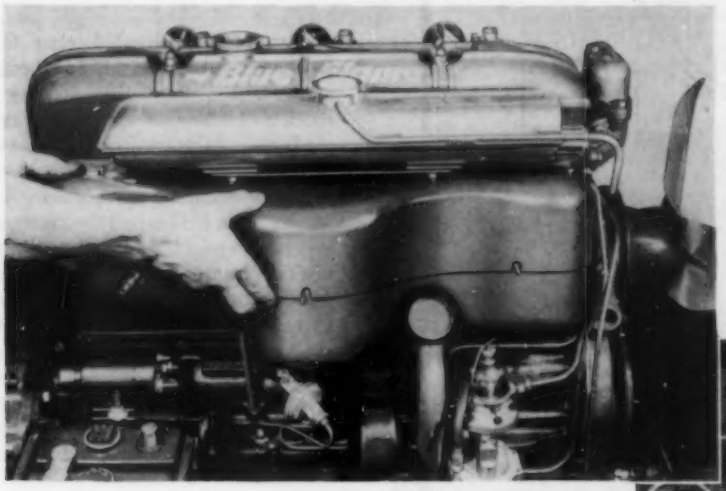
INNER DOORS feature package or road accessory compartments in the interior paneling.



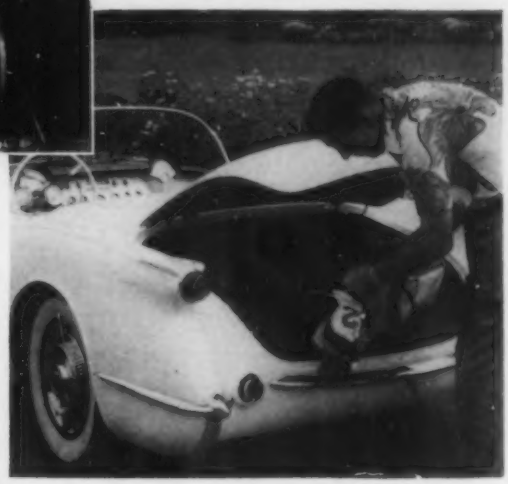
REAR VIEW OF CHASSIS, a box section frame having an X-member structure of I-beams, shows outboard mounting of rear leaf springs and Hotchkiss drive. Note dual exhausts. Exhaust system has precisioned tuned mufflers to give typical sports car "roar." Also shown are mounting brackets for attaching plastic body, a total of 11 brackets being used.

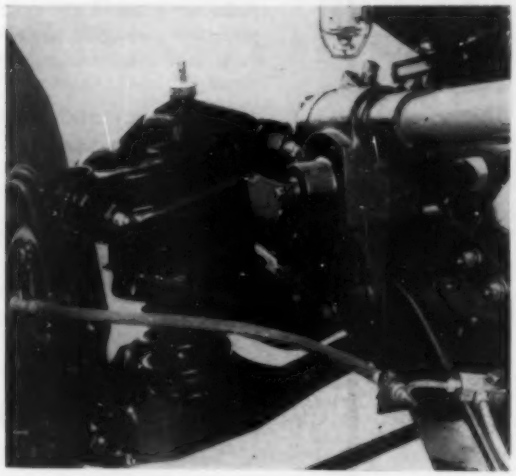


ENGINE ELECTRICAL system requires shielding to prevent radiation of radio frequency interference through plastic body. Metal shield covers distributor, spark plugs and coil. Also, coaxial condensor is used for primary circuit. Other shielding means include two additional coaxial condensors for generating circuit.



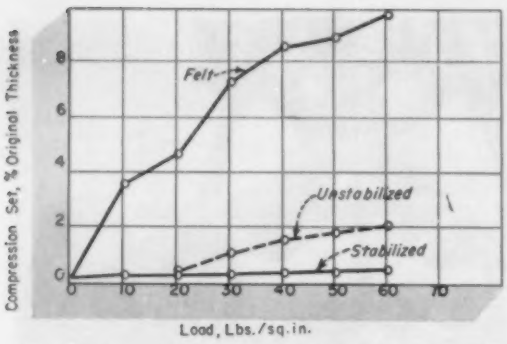
BUMPER ARRANGEMENT signals a new approach to an old problem. While designed to give adequate protection, bumpers appear to only do part of the job. Note spacious 10 cu ft luggage compartment. Additional storage space is in built-in box sections on insides of doors, not shown in this view.



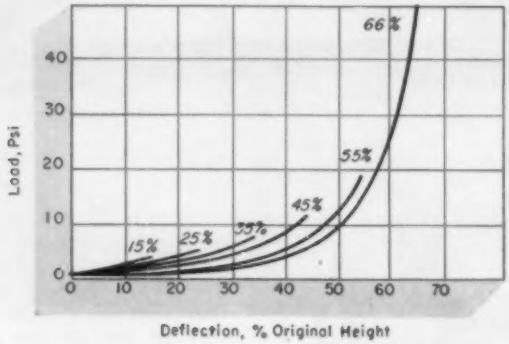


FRONT SUSPENSION is the long and short arm independent type with low rate coilsprings Shock absorbers are direct double-acting type. Fast steering ratio, 16 to 1, gives sports car sensitivity and better wheel control.

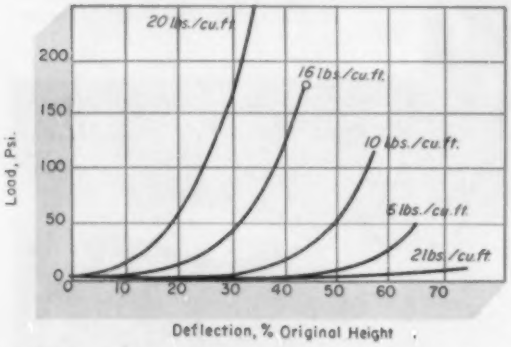
Load-Deflection Characteristics of Glass Fiber Mat



(A) Negligible permanent set of preloaded or **stabilized glass fiber** cushioning compares favorably with that of felt and **unstabilized** material. Stabilized material **was** pre-loaded to 100 **psi.**



(B) Principle of pre-loading resin-bonded **glass fiber** cushioning, showing effect of successively higher loads on deflection.



(C) Range of load-carrying properties obtained from standard density cushioning materials. Spring rate depends on density.

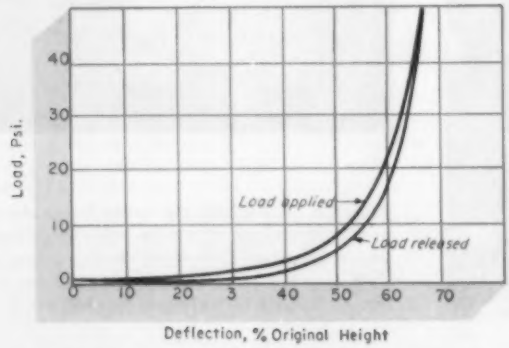


Fig. 1

(D) Static load vs deflection curve showing hysteresis loop. Six lb/cu ft density material was stabilized for 66 percent deflection.

Vibration Of Glass

SOL MUSIKANT*
Glass Cushion Engineering Company,
Great Neck, N. Y.

ALTHOUGH resin-bonded glass fiber has been used extensively for thermal and acoustical insulation, its use in shock and vibration damping is relatively new. Because of internal friction between fibers, the material possesses excellent damping properties. But when pre-loaded beyond the maximum expected service load, it also exhibits negligible permanent set. After load release, it returns almost immediately to initial dimensions, Fig. 1. This property, augmenting resiliency, damping power, chemical inertness, moisture resistance, non-combustibility, and stability of these qualities over a broad temperature range, permits the use of the material as vibration isolators in blowers and electronic gear, shock pads, heavy machinery mountings, and protective packaging of delicate equipment and electronic components.

Resiliency and Damping Properties

The spring rate of pre-loaded resin-bonded glass fiber cushioning depends primarily on its density. At a unit load of 50 psi, for example, material of 20 lb per cu ft density deflects 20 percent of its initial free height, while material of 6 lb per cu ft density deflects 66 percent of its initial free height. Other densities of glass fiber cushioning follow a similar pattern.

* *Formerly, Chief Engineer, Vibraglass Division, Glass Fibers, Inc.*

Damping Characteristics Fiber Cushioning

As the density increases, the material stiffens because greater force is required to strain the increased number of fibers in the cushioning.

The necessary design data for estimating forces and deflections as related to density are presented in Fig. 2, in which density is plotted against deflection and the lines of constant load are drawn to present the complete pattern. In order to select the proper density to carry a given loading, 10 psi for example, the appropriate load line is traced to reveal the deflection for each density at this load level. Thus, 5 lb per cu ft density cushioning will deflect approximately 52 percent of its initial free height. If design requirements call for less deflection at the 10 psi loading, then 15 lb per cut ft density cushioning may be selected for deflection of approximately 18 percent of initial free height, at the 10 psi loading.

These data are useful only if the direction of force in the given application is perpendicular to the sheet. Resin-bonded glass fiber resilient properties are essentially uni-directional. Resiliency and strength in the direction parallel to the plane of the sheet are relatively low, and forces in this direction should be minimized in any application. This uni-directional characteristic results from the parallel lay up and horizontal orientation of the fibers during manufacture of the material. The parallelism of the fibers imparts the high degree of resiliency and is an essential feature of this type of cushioning bonded with phenolic resins.

Line B is a recommended design line for vibration isolation applications. Thus, in any given case, the designer can specify sufficient area of pad to provide the recommended unit static load condition for the density selected. In general, the lower the density selected, the greater degree of isolation achieved for a given thickness of pad. Conversely, excursion, dynamic deflection, increases as the density of pad goes down. Of course, increase in thickness of pad has an effect on isolation inverse to increase in density. Loads or deflection should not exceed the conditions on line A, or the initial properties of the cushioning will drift.

The repeatability performance of

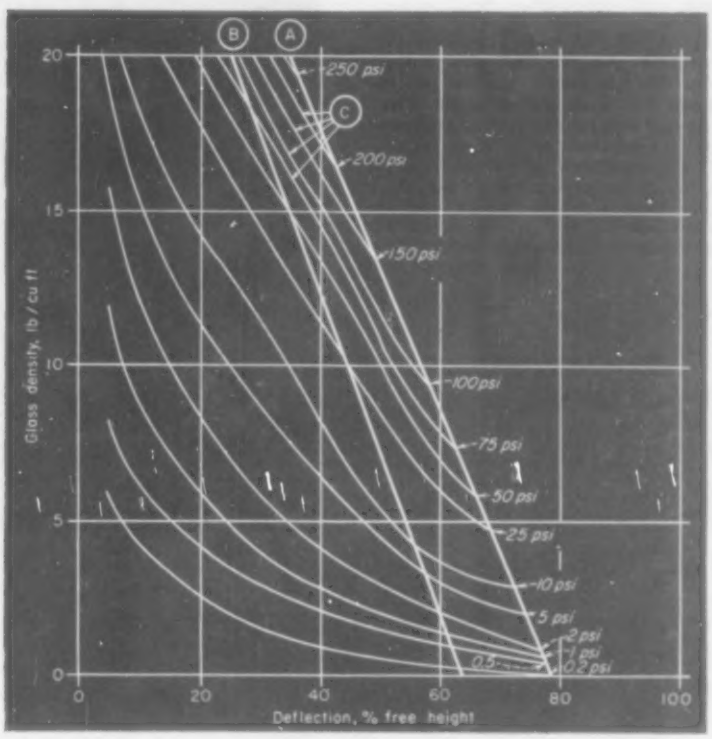


Fig. 2—Selecting density for given loading. Line A represents normal stabilization points recommended for repeated loading and unloading; line B, recommended working deflection limit percent of free height during repeated loading and unloading; and line C, where indicated, represents the line of constant pressure.

resin bonded glass fiber cushioning is extremely good. In a durability test conducted on 9 lb per cu ft density cushioning, the material was compressed repeatedly to a deflection of 25 percent of its initial free height, and intermittently its resistance was measured at 25 percent deflection and at 40 percent deflection. The results indicated very little drift after approximately 1,000,000 cycles. Therefore, under repeated compression within the recognized limits of resin-bonded glass fiber, the constancy of its characteristics is excellent. There is negligible set, despite the internal energy absorption. The area within the hysteresis loop is indicative of the damping effect to be expected when resin-bonded glass fiber is used as a shock or vibration isolator. The damping power of this material compares favorably with other vibration isolating media, such as a steel spring suspension, Fig. 3. In an acceleration test where a 5-inch cushion of resin-bonded glass fiber and the undamped steel spring arrangement were subjected to a 36 in. free drop of a 7 lb mass, the impulse was damped out in about 1½ cycles in the glass fiber pack. The steel spring arrangement required approximately 30 cycles to damp out. This comparison offers convincing evidence of the damping quality of resin-bonded glass fiber.

Shear Strength

One present limitation of resin-bonded glass fiber is that shear loads super-imposed on the compressive loads will increase the drift, Fig. 4.

However, the apparent shear strength increases if the material is placed under compression. This indicates that resin-bonded glass fiber will resist failure due to shear forces more effectively if compressed, when subjected to dynamic loads in more than a single plane. For this reason, in certain of the fabricating operations and in the design of some products, compressive forces are maintained on the pad at all times.

Current development to enhance the sheer strength of this material also includes the investigation of various types of coatings, including rubber and vinyl types. In one type of mounting design, the glass fiber pads were coated with buna-N rubber which tended to reinforce the glass fiber against possible failure due to shear loads. In this design two cylindrical end pads were also employed to take out shocks in the axial direction. In addition to the end mounts there were four rail assemblies spaced at 90 deg. intervals to take out lateral shocks in any direction. Each of these rails incorporated three glass fiber pads. Sliding action was permitted between the electronic unit being protected and the rails, by means of a stainless steel track on each of the four rail assemblies, so that axial motion was permitted without applying shear loads to the pads in the rails.

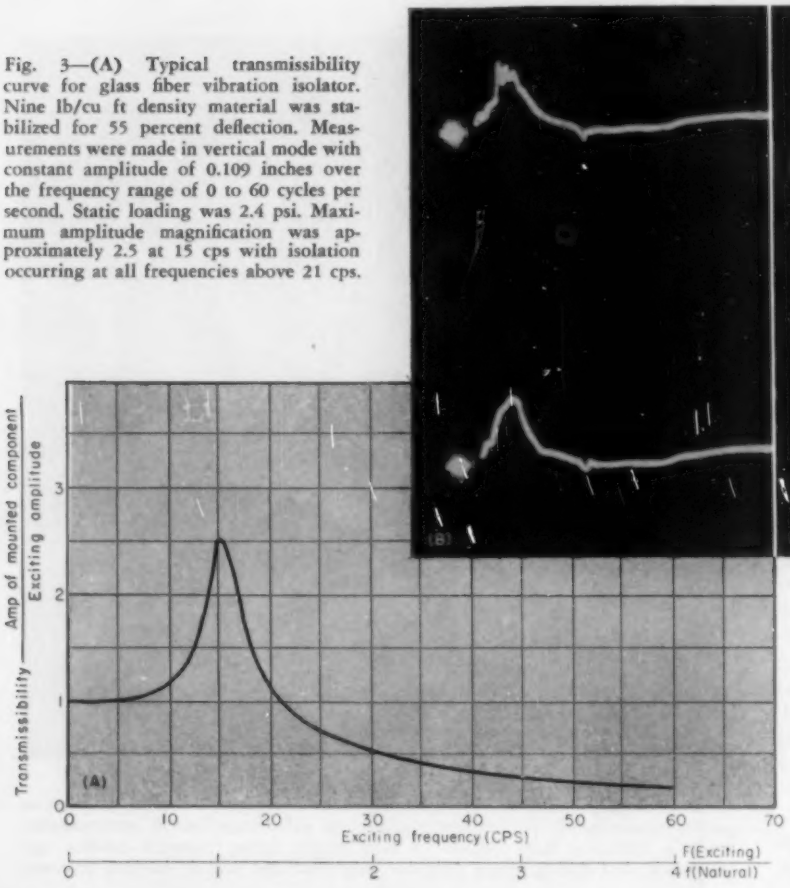
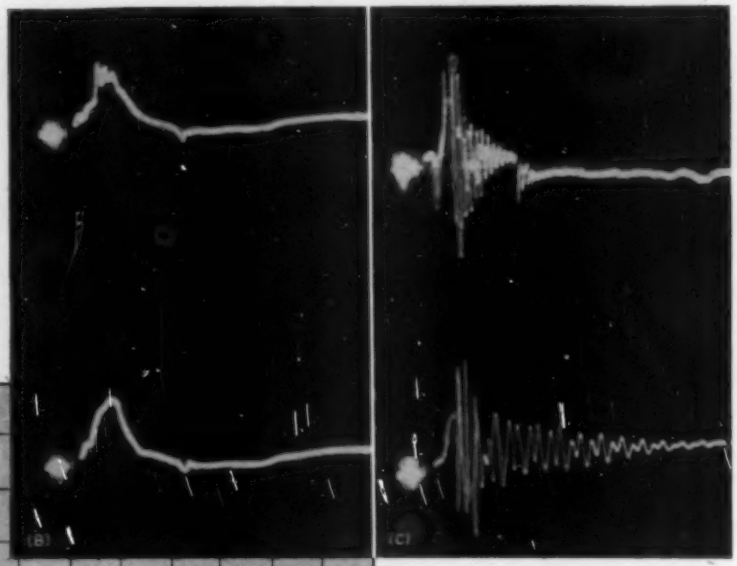


Fig. 3—(A) Typical transmissibility curve for glass fiber vibration isolator. Nine lb/cu ft density material was stabilized for 55 percent deflection. Measurements were made in vertical mode with constant amplitude of 0.109 inches over the frequency range of 0 to 60 cycles per second. Static loading was 2.4 psi. Maximum amplitude magnification was approximately 2.5 at 15 cps with isolation occurring at all frequencies above 21 cps.



Damping quality of glass fiber cushioning, (B), and steel spring suspension, (C). Impulse damped out in 1½ cycles in glass fiber, 30 cycles in steel spring suspension.

Serviceable Temperature Range

This type of cushioning is serviceable over a broad temperature range. From —65 F to 165 F its resilience is affected only slightly and it remains pliable and usable from —100 F to 375 F. Although the material is noncombustible, the binder tends to decompose above 425 F. In Fig. 5, which illustrates the effect of temperature on load-deflection properties, the stated temperature extremes caused a variation in stiffness of only 10 percent. In applications where great temperature variations may be encountered, such as the packaging of military equipment, this temperature stability is very important. In a motor mount operating above 200 F continuously in a production household appliance, glass fiber mounts are employed as replacement for conventional rubber mounts which aged rapidly and failed because of the elevated temperature.

Special Design Factors

At present, resin-bonded glass fiber cushioning does have certain limitations which can be obviated by design precautions. Since its properties are essentially uni-directional, it is considerably stiffer and less resilient in the direction of the plane of the laminations. Forces parallel to the plane of the sheet should therefore be minimized. To compensate for its relatively low shear strength, all lateral loads should be taken by suitably oriented pads combined with provision for relative motion between the mounted item and the mount—or pads coated with vinyl or rubber should be employed. As the material also exhibits a distinct yield point, highly concentrated point loads should be avoided. In the packaging of delicate instruments, static loads—weight of the object divided by bearing area—should be in the range of .02 to 1.3 psi. In general, the more fragile the object, the lower the initial static load should be. However, for heavier objects, the higher density materials can accommodate static loads as high as 50 psi. Again, the required cushion thickness is a function of fragility. The greater the thickness of cushion provided, the greater the protection. If these general precautions are observed, the cushioning's performance should be satisfactory in most load designs.

Future Development

In improving resin-bonded glass fiber for future applications, a number of fundamental variables are being investigated including fiber diameter, resin type, proportion of resin used, cold working treatments, and coatings. An object of future development is to provide resins which will improve the durability of the material especially in resisting shearing loads, offering greater resilience in the transverse direction, and imparting increased tensile strength. Research on binding has already indicated possible improvements. To date phenolic and thermosetting type resins have been predominant, usually 10 percent in content of the cushioning. But the entire field of thermoplastics is open to investigation as well as the asphaltic materials. Application-wise, the potential uses of resin-bonded glass fiber cover the complete field of resilient materials including office machine padding, aircraft type vibration mounts, heating and ventilating equipment protection, heavy machinery mounts, and gaskets and dust seals coated for particular performance.

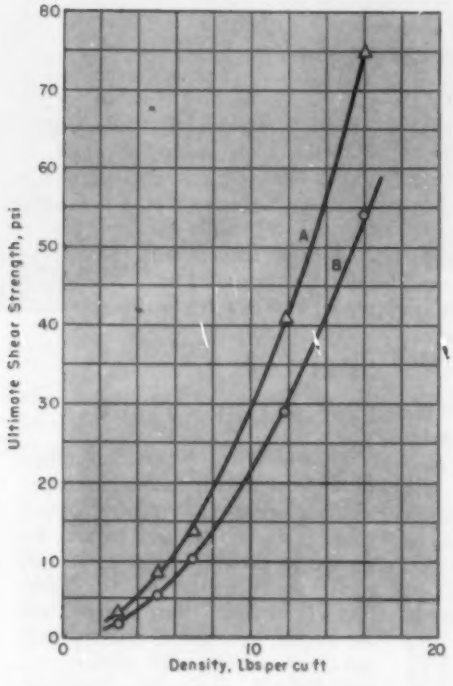


Fig. 4—Shear strength data for various densities of material. Curve A represents compresssive load of 33 1/3 percent, curve B, no load.

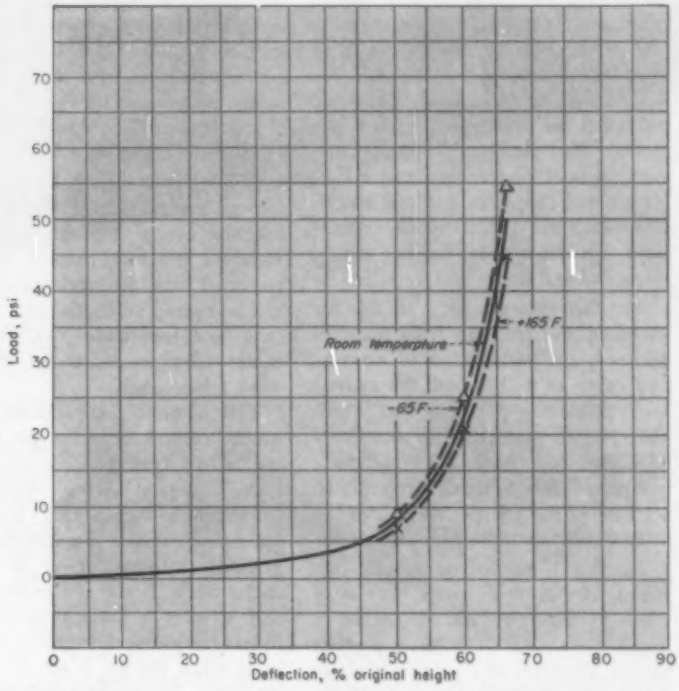


Fig. 5—Effect of temperature on deflection rate of 6 lb/cu ft density material. Stiffness variation between —65 F and 165 F was only 10 percent. Binder, however, tends to decompose at comperatures above 425 F.

A Progress Report On Shielded-Tungsten

The significant expansion taking place in the use of aluminum, magnesium, stainless steel and other thin-gage materials is stimulating the application of this high-speed welding technique. Equipment, jigging, shielding gases, joint design and the various weldable metals are discussed.

H. A. HUFF, Jr. and
A. N. KUGLER
Air Reduction Sales Company

WHILE THE INDUSTRIAL USES of any effective welding process are diverse, the inert-gas shielded tungsten arc—or Heliweld—technique is mainly associated with the light-gage sheet metals that oxidize rapidly. Peak efficiency is realized on material up to $\frac{1}{8}$ in. thick and the thinner gages that can be welded without filler metal. Materials on which the process has proven successful are aluminum, magnesium, stainless steel, high temperature alloys, copper and copper base alloys, nickel, and titanium. Under special conditions, it is also used for welding carbon steels and cast iron.

The Heliweld process is notable for its speed and freedom from flux. In addition, the wide range of currents and gases, as well as both the manual and automatic equipment now available, permits application to most types of design and weld. With automatic equipment and a highly concentrated arc, 0.032-in. 2S Al sheet can be welded at a rate of 180 in. per minute.

No flux is needed on rapidly oxidizing hard-to-weld metals, because of the high density arc and the helium or argon gas shield. The latter protects the arc, electrode and weld from active elements in the atmosphere, while the former permits high travel speeds and reduces thermal distortion.

EQUIPMENT

Tungsten-arc welding can be accomplished with manual, machine (semi-automatic), and automatic equipment that is backed up by accessory elements for a wide variety of special uses. Three types of manual holder are: (1) an integral water-cooled holder for general use, (2) a water-cooled holder (separate attachment) for applications where alternating current is used and large-diameter tungsten electrodes are required, and (3) an air-cooled holder for light-duty work.

Semi-automatic equipment, involving the use of machine holders, is mounted in a fixed bracket. It can be traversed over the work, or the work can be moved under the arc. Fittings built into the holder bracket permit minor adjustments in the electrode-work relationship.

The automatic application of the process centers around a special welding head. Through a series of electronic circuits, drive motors and automatic devices, this equipment maintains constant arc length and is vertically self-positioning in relation to the work. It also strikes its own arc and actuates a motor-driven carriage to traverse either the work or the head itself when the arc is struck. For establishing the arc on the lighter gage materials, high frequency current can be used without touch starting. This prevents contamination when working with small-diameter tungsten electrodes.

The principal auxiliary equipment is the filler wire feed mechanism. This can be used in conjunction with a standard machine holder or with an automatic head to regulate wire speeds in the range from 15 to 200 in. per minute.

A recent development is the application of the shielded tungsten process to the spot welding of stainless, mild and alloy steels up to $\frac{1}{8}$ in. thick. A light-weight, d-c powered gun with a $\frac{3}{32}$ in. thoriated electrode is positioned on the work and the trigger pulled. No jigs or fixtures are needed. The gun is water-cooled and uses helium, argon, or a mixture for the shield.

SPECIAL CONSIDERATIONS

To achieve the process advantages of improved weld quality, increased welding speed and reduced overall costs, precision jigs and fixtures are needed to present a joint to the arc under prescribed conditions. Tolerances in variables, such as speed and arc length, are limited, making small deviations critical, and uniform accurate joint preparation necessary. Speeds typical for automatic or semi-automatic welding are so high that

Arc Welding

Tilting jig permits down-hand welding of magnesium wall forms. Filler metal is used at inside corners.

time is not available to adjust and compensate for variations in the joint fit-up as in manual welding.

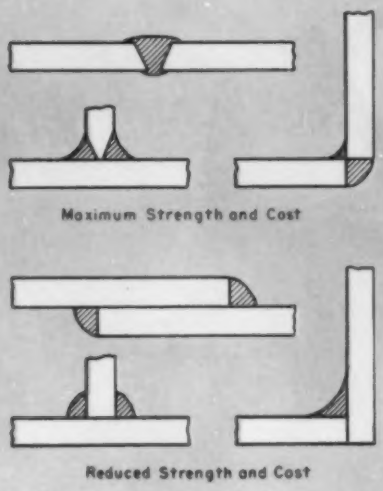
In machine or automatic welding, the factors of alignment require careful study. Alignment of components in an assembly follows not only fit-up factors but also evaluation of the effects of expansion and contraction induced by the heat of welding. In simple cases, empirical rules aid in predicting the end result; in more complex assemblies, it may be necessary to fabricate several pilot models.

HELIUM vs ARGON

There are important differences in the electrical effects of argon and helium, which in themselves increase the suitability of this process for a wide range of work. For example, the voltage per unit of arc length with helium is very much greater—and thus "hotter"—than it is with argon. The helium arc is more penetrating, and, in many cases, adverse heat effects are present to a lesser degree.

The nature of the work determines to a great extent the shielding gas best suited for the job. Helium is the better gas for work where high heat conductivity is an important factor. Argon is preferable in the manual welding of thin materials where burn-through might occur. When machine welding thin material, the arc length is more constant than in manual welding, so helium is more serviceable. Mixtures of helium and argon have been found to produce the best results on many welding jobs. Experimentation determines the proper gas mixture.

Fig. 1—Common types of joints. Upper row shows configurations for optimum strength and cost. Designs in lower row represent some strength reduction, and must be used wisely when dynamic loading is anticipated.



Suckle Electronics Company

Fig. 2—Two 14 in. seams on radar box are welded with track-guided head in less than four minutes. Material is 1/16 in. 52S aluminum sheet. No. 20 Radiograph traverses holder back and forth over the two seams at rate of 18 in. per minute.

JOINT DESIGN

For optimum strength and reliability, only a full section weld should be used, Fig. 1. Such welds, however, require the most careful preparation and are usually the most costly to make. It is, therefore, wise to adjust the needs of the job in terms of strength as against the cost of producing the joint under existing shop conditions.

Wherever joints are short, irregular or hard to reach, or when the quantity or uniformity of work does not justify more elaborate methods, manual welding is recommended. Depending on the application, filler metal may or may not be fed into the arc. When filler is required, the operation can be accomplished in much the same manner as in oxyacetylene welding.

Use of filler metal is often determined by the type and thickness of the material being welded. With aluminum, filler metal is generally used if the thickness is more than $\frac{1}{8}$ inch. On stainless and nickel alloys (Monel, Inconel, etc.), it is frequently possible to get by without filler metal on sheet up to $\frac{1}{8}$ in. thick when joint design and jigging are correlated to produce a reinforced weld.

This correlation is merely a question of whether back-up can or cannot be used. If a weld is backed up and properly restrained with lateral pressure, there will be reinforcement at the face and root of the weld. Without back-up, the root will sag, creating a depression in the face which can be corrected only by filler metal. The problem of back-up depends on whether the design of the pieces to be welded permits its use.

ALUMINUM

As noted above, the shielded tungsten arc process has its greatest use on thin gages of aluminum. Until recently, the best technique has been alternating current with argon, but a newer method uses direct current helium shielding and thoriated tungsten electrodes. This method is recommended for machine and automatic set-ups where the critical variables are more readily controlled then in manual welding.

The Gray Manufacturing Company of Hartford, Conn., is automatically welding 0.064 and 0.090 in. thick 52S aluminum at rate of 30-32 in. per min using helium and direct current. This is in contrast to 9-10 in. per min formerly obtained with argon and alternating current. For manual operations on the same thicknesses of material, argon or a mixture of both gases is more successful.

In a second instance, the Suckle Electronics Company of Camden, N. J. is turning out 45 aluminum radar cases a day with the machine set-up shown in Fig. 2. A track-guided No. 20 Radiagraph carries a machine holder over two sections of the box. Progression rate of the Radiagraph is 18 in. per min; this permits completion of a 14-in. seam on $\frac{1}{16}$-in. thick 52S aluminum in approximately 45 seconds. The case is then turned over, the Radiagraph is reversed, and the second seam is completed on the return pass. After two round trips, which take less than four minutes, the case

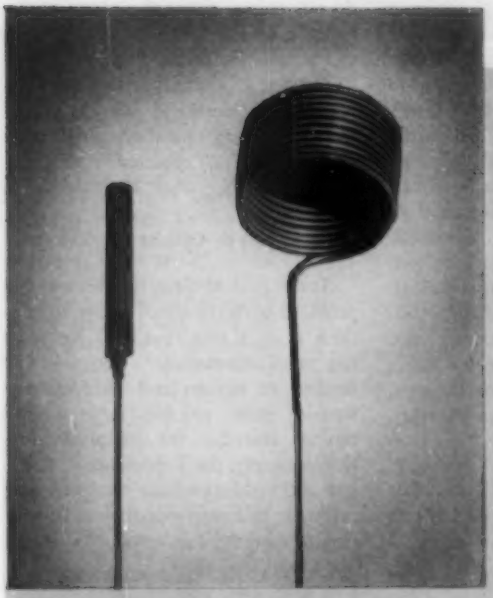


Fig. 3—Manually-welded assemblies of Type 308 stainless steel capillary tubes with larger elements. A ¼ in. electrode is used with 20-amp straight-polarity d-c and helium.

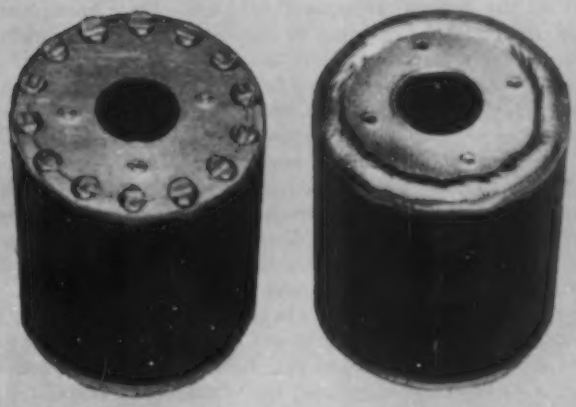


Fig. 4—Copper rotor assembly for fractional horsepower motors. Preliminary mechanical assembly is at left. Finished unit at right is welded on both ends at rate of one every minute. Tungsten electrodes and helium are used.

is ready for manual welds on the corners.

In both the above applications, thoriated tungsten electrodes are used in place of the standard type. With these improved electrodes, there is less risk of contamination; the electrode clears itself quickly without disturbing the arc. They also have considerably greater current-carrying capacity. The thorium oxide on the surface of the cathode emits about 90 times as many electrons per unit of surface area as does pure tungsten.

MAGNESIUM

This metal is said to be the first that was successfully welded by the shielded tungsten arc process. The fact that flux is unnecessary dispels one of the doubts always attendant upon gas welding magnesium: The corrosion caused by flux residue.

Magnesium can be welded with reversed-polarity d-c and helium, with high-frequency a-c and argon, or with balanced a-c and a 50-50 gas mixture. Joint designs are substantially the same as for other forms of welding. For materials up to ⅛ in. thick, the square groove butt joint is satisfactory, because the arc is sufficiently penetrating.

STAINLESS STEEL

Cleaning cost is often a major factor in the fabrication of stainless steel. Production reports indicate a decrease from 40 to 80 percent in these costs when using Heliwelding rather than coated-electrode procedures. But if savings attributable to grinding do not offset the cost of fit-up and welding, the conventional electric arc or oxyacetylene processes may be economical.

Usually, two requirements have to be met before the tungsten arc process can be economically applied to thin sections of stainless steel on a machine or automatic basis: (1) Parts must be designed to provide good fit-up, and (2) they must be held in proper alignment by substantial jigs and fixtures. The gain in welding speed and the reduction of cleaning costs offset the expense of these features. This has been the case in welding stainless steel vessels to meet sanitary needs.

In manual welding of stainless steel by this process, either the forehand or backhand technique as defined for gas welding can be used. The conditions surrounding the application usually dictate the direction of welding. Manual welding of capillary tubes made of Type 308 stainless steel, Fig. 3, exemplifies this point.

HIGH-TEMPERATURE ALLOYS

In the use of the Heliweld process on thin sections of high temperature alloys, such as 347 stainless, Inconel X, Nimonic and Timken Alloy, there are several inherent advantages. High travel speeds and small diameter electrodes mean a narrow heat-affected zone. Use of the process without filler metal in many butt welds enhances soundness in joints. When filler metal is required, the transfer of alloying elements across the arc is highly efficient, and the risk of elements going

out of solution is reduced. The minimized heat effects mean also that considerable welding can be done on these materials—many of which are essential to the jet program—without subsequent heat treatment.

COPPER AND ITS ALLOYS

When copper's high capacity to conduct heat from a weld point is considered, the process advantages of rapid, concentrated heat input to the work become apparent. As there is a tendency for a very fluid metal to flow ahead of the arc, it is desirable to weld up hill at an angle of 10 to 15 degrees. On small sections, and on thicknesses up to $\frac{1}{4}$ in., neither flux nor preheating is usually necessary. The inert-gas-shielded metal arc process (Aircomatic*) should be used on thicknesses greater than $\frac{1}{8}$ in., and on large masses. When Heliwelding is applied to large masses, preheating is necessary to permit faster welding speeds and insure sounder welds. Large cast copper sections should be preheated to about 600 F, and this temperature maintained continuously during welding to prevent formation of residual stresses.

The production of rotors for fractional horsepower motors has been facilitated by the introduction of this process. Fig. 4 illustrates an assembled rotor with copper end plates and projecting copper bars coined for temporary holding. The part is then preheated to permit maximum weld speed, placed on a rotating table under a machine holder, and welded, using straight-polarity d-c at 150 amperes, $\frac{1}{4}$-in. tungsten electrodes and helium.

Heliwelding is also well suited to silicon bronzes, aluminum bronzes, manganese bronzes and some brasses. Welds in silicon bronze meet ASME code U-68 for Unfired Pressure Vessels. Large manganese bronze castings can be successfully welded using aluminum bronze filler metal, even though the color match is not perfect.

NICKEL

Joint designs for nickel and nickel alloys are substantially the same as those recommended for stainless steel. Welding usually calls for straight-polarity d-c with helium gas, although a-c with argon can be used. The important factor is filler metal. Irregular results were obtained with the Heliwelding process on nickel and nickel alloys until several special types of filler wires were developed. These are basically the same composition as the base materials. Small quantities of other elements have been added to promote weld soundness and insure that melting and remelting do not reduce these elements. These additions do not reduce either the corrosion resistance or the mechanical properties of the base materials.

The use of these special wires does not obviate the need for close control of welding operations. Adequate gas coverage is required and minimum arc lengths must be maintained.

TITANIUM

At the present time, there is one big problem with titanium: How to produce it at a cost that will make its use more economical? Being highly reactive to oxygen and nitrogen, the wonder metal requires large quantities of inert-gas for its production. Consequently, the importance of inert-gas arc welding—both tungsten and metal arc processes—is obvious in relation to working this metal.

CAST IRON

Heliwelding permits welding of cast iron, without flux in a manner paralleling the oxyacetylene method. It is usually necessary to preheat the casting in the range from 900 to 1,400 F, and to maintain the preheat during welding. This operation can be omitted on small parts and at isolated sections of large parts. Speeds are higher than those obtainable with comparable processes, but at such speeds there is a tendency to cover hidden defects.

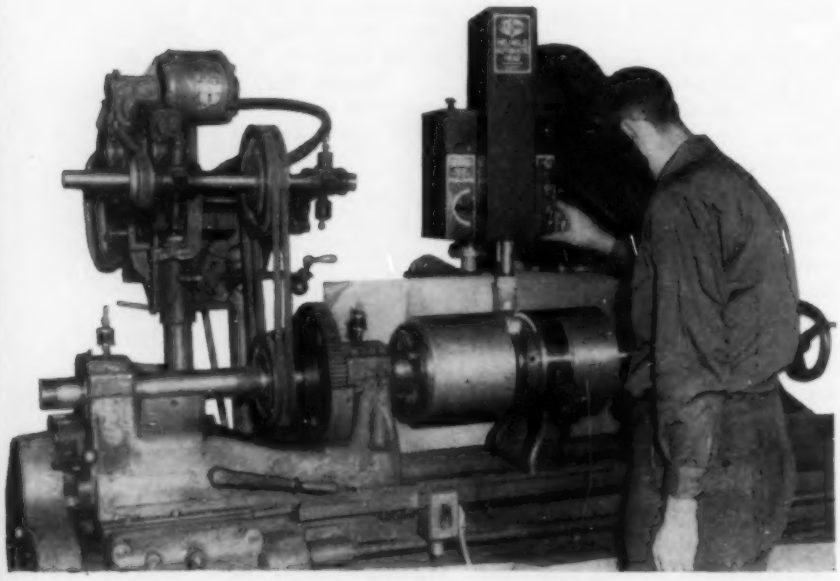
CARBON STEELS

The welding of carbon steels points up the process advantage of preserving the composition of filler metal. The core in ordinary rim steel, when welded by this process, always causes porosity to develop as a result of rapid melting and solidification of the weld pool. The use of filler metal containing a deoxidizing agent appears to be the solution. When using the Heliweld process, killed steel is recommended. No filler metal is required.

GENERAL TREND

Research and development programs for this shielded tungsten arc process are moving toward the extension of present applications through the design and production of new specialized equipment, both of the manual and automatic variety, and through the refinement of welding procedures.

* *Registered Tradename.*



Automatic welding heads can be adopted to a variety of special rigs.

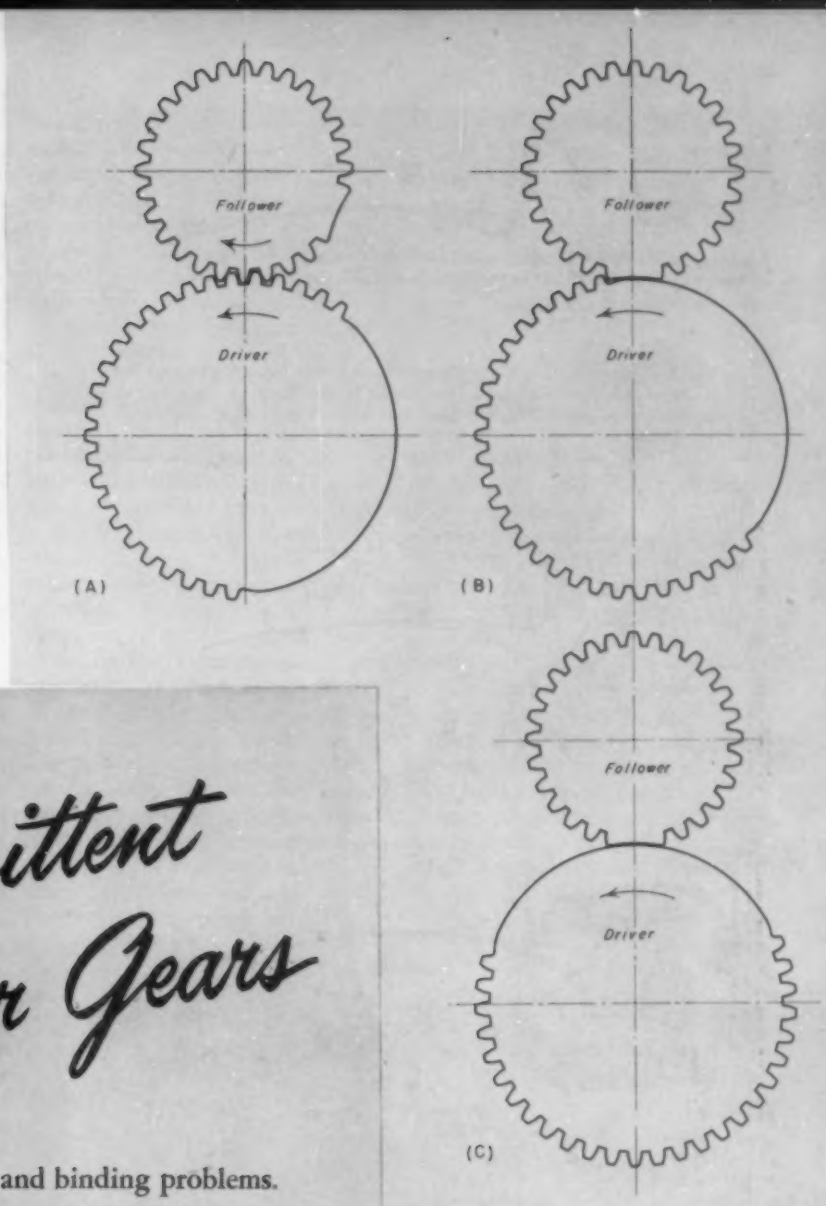


Fig. 1—Operating cycle of a pair of intermittent spur gears. In (A) action is identical to that of conventional spur gears. The follower begins its dwell at (B), while the driver continues to rotate, (C). The follower remains in this locked position until the first tooth of the toothed segment of the driver contacts the flank of the follower land.

Intermittent Spur Gears

Discusses interference and binding problems. Also describes a recent development that avoids most of these difficulties.

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INTERMITTENT SPUR GEARS have often been used for the transmission of intermittent rotary motion. Simplicity of design, relative ease of manufacture, and a wide range of applications, are important advantages which these gears have when compared to other types of mechanisms that provide non-uniform motion. There is almost no limit to the possible combinations of motion which can be obtained, just as the possible ratios in conventional gearing are practically numberless.

The two members of a pair of intermittent gears are designated as the driver and the follower. In simple terms, the operation is as follows:—Starting with the toothed portions of the two members in mesh, Fig. 1(A), the action is identical to that of two conventional spur gears at standard center distance; the rotation of both members continues to a point where the concave portion of the periphery of the follower, with its curvature equal to that of the pitch line of the driver, coincides with the cylindrical "land" surface of the driver, Fig. 1(B)—at this point, the rotation of the follower is stopped while the driver continues, Fig. 1(C). The follower is now locked in position, and remains so until the first tooth of the

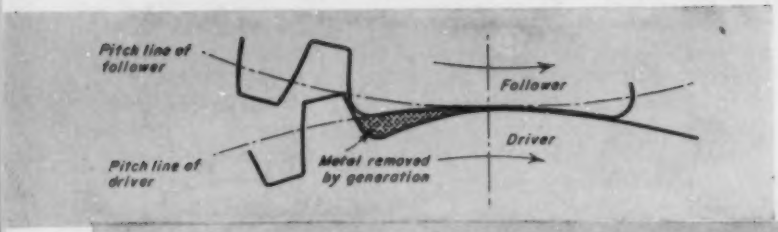


Fig. 2—Enlarged view of the driver and follower lands shows that the shape of the dwell or land of the driver is generated by the shape of the follower lands. Follower land has involute curves at either end.

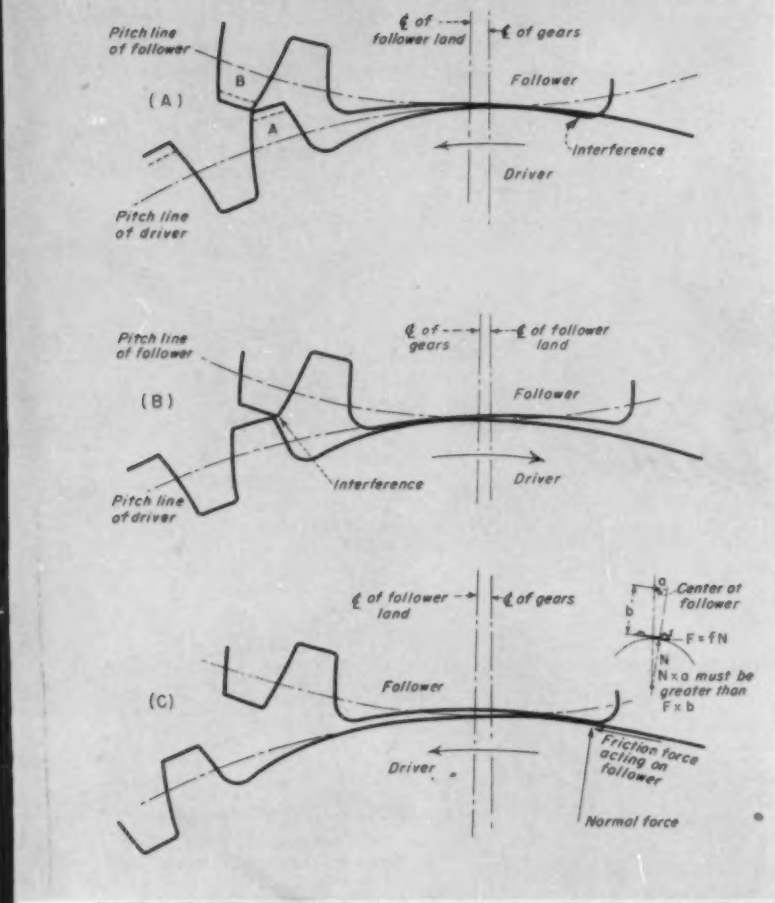


Fig. 3—TYPES OF INTERFERENCE

(A) Interference may occur where the follower is brought into its indexed position. It can be eliminated by shortening the addenda of the teeth as indicated by the dotted lines. (B) Another type of interference can occur when the driver is approaching the idle follower. It can usually be corrected by controlling the clearance between lands or by filing the corner of the interfering tooth. (C) A third type of interference is a tendency to bind while the follower is idle because of the friction force at the contact point between the lands. It can be eliminated by increasing the length of the follower land or by relieving the center portion of this land.

toothed segment of the driver comes into contact with the flank of the follower land. The cycle then repeats. Operation may be in either direction.

Obviously, the shock of the follower being picked up by the first driver tooth limits the practical applications of intermittent gears to those cases where speeds are low or kinetic energy values are reasonable. However, within these limits, a variety of motions can be developed by varying the number of lands on the driver and follower. For example the driver will make three revolutions for every one of the follower, if the follower has three lands and the driver one. Each of the three toothed segments of the follower in this case would have the same number of teeth as spaces in the toothed segment of the driver.

While the basic concepts of intermittent gears are quite simple and straightforward, some aspects of their design and manufacture can lead to troublesome operation. The difficulties encountered are primarily due to interferences which occur at the point where the first tooth of the driver is about to pick up the first tooth of the follower, and again at the point where the follower is approaching its stationary or "indexed" position.

It may be seen from Fig. 2, that the shape of the driver in the area where its land joins the first tooth is "generated" by the shape of the land on the follower. Note that the land on the driver dips below the pitch circle at this point. The follower land is bounded on each end by an involute curve which would be the flank of a tooth if the follower were a conventional spur gear. A radius joins this involute curve with the top of the follower land.

One of the various types of interferences which may be encountered, is illustrated in Fig. 3(A). The follower is being brought to its dwell or idle position. The driver rotates the follower until the tip of the driving tooth "A" clears the tip of the driven tooth "B". However, before this point is reached, the right end of the follower land has interfered with the driver as shown. This type of interference is likely to occur when the follower land is relatively short, but can easily be corrected by shortening the addendum of each gear slightly, as indicated by the dotted lines. The possibility of a longer land might also be considered.

A second type of interference which can occur is illustrated in Fig. 3(B). In this case, the first tooth of the driver is approaching the point where it will pick up the follower which has been idle. Because of clearance between the lands, the follower has "rocked in" as shown, causing the tooth following the first space on the follower to interfere with the tip of the first driver tooth. The degree of interference varies with the clearance between the lands. This problem can be eliminated by keeping this clearance at a minimum, or if clearance cannot be corrected, by filing the corner of the interfering tooth.

A third condition which must be avoided is a binding or toggle action which occurs during the idle portion of the cycle. Referring to Fig. 3(C), it is obvious that if the friction force $F = fN$ at the point of contact between the lands causes a greater moment about the center of the follower than does the normal force N in the opposing direction, a locking toggle action will occur. This tendency to bind depends somewhat on the coefficient of friction between the two surfaces, but more strongly on the length of the follower land. The longer the land, the less the chance of binding.

This condition exhibits considerably stronger tendencies as the first tooth on the driver is about to pick up the follower. In this region, the curvature of the driver land increases causing the point of contact between the two lands to suddenly approach the center of the follower land as the follower rocks in. This in turn, causes the moment arm of the normal contact force to decrease substantially, greatly increasing the possibility of a binding toggle action just before the first tooth picks up. When this condition exists, and a longer follower land is out of the question, it may be remedied by relieving the center portion of the follower land, forcing the contact point towards the land tip.

Recently, a new concept for intermittent gears which eliminates most of the interference and binding problems, has been developed. In addition, it permits simpler layout and easier manufacture of the gears. Fig. 4 illustrates this new form. The shape of the driver in the transition zone between teeth and land is simply that of a conventional tooth space. The land does not dip below the pitch line as formerly, but remains at the pitch line until it meets the tooth space preceding the first tooth. Correspondingly, the follower land consists simply of two conventional teeth at the extremities of the land, the tops of which are formed by the radius of the land. The teeth which would normally lie between these two end teeth are cut away to the root circle to prevent their interfering with the driver land when an indexing is starting or finishing. Note that the follower may be cut as a complete conventional gear, and then the land milled to the correct radius, followed by removal of the middle teeth.

This form has certain advantages in that the follower is completely and precisely indexed by gear tooth action as shown. Formerly, an index was completed by the first portion of the driver land at a point which could vary over a range of several degrees of driver rotation. Another important feature of this form is that, just before the driver picks up the follower for an index, the follower cannot "rock in" and cause a bind or an interference. This is because the land on the driver does not suddenly increase its curvature just ahead of the first tooth, but maintains the curvature of the pitch circle up to the space immediately ahead of the first tooth. Thus the point of contact between the lands of the driver and follower is always at the tip of the follower land and the follower is accurately fixed in its dwell or indexed position right up to the point where the first tooth of the driver picks it up, see Fig. 4(B).

It appears that the only type of interference which this form may be subject to is that shown in Fig. 3(A), where the follower is being brought to its dwell position, and which may be corrected by shortening the addenda of the interfering teeth.

In laying out the follower land for this form, the number of circular pitches which the land will include must be such that the radius of the land creates sufficient bearing surface on the two end teeth. It is possible to select a number of teeth for the land, resulting in little or no bearing surface.

Also, it is good practice to lay out the gears in the vicinity of the lands to as large a scale as possible on heavy paper. If these layouts are then cut out and mounted at scale center distance, their operation can be observed and any interference found and corrected before the gears are made.

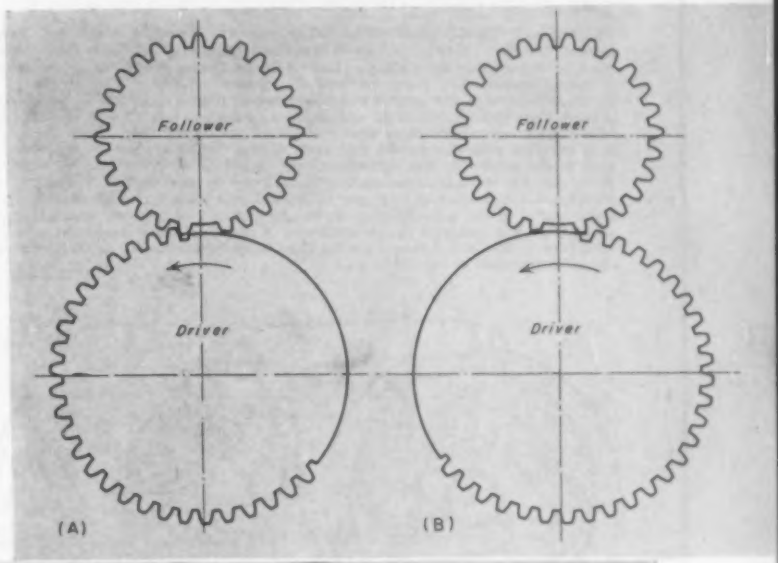


Fig. 4—New concept of designing intermittent spur gears does away with most interference and binding problems. The follower land consists of two conventional teeth whose tops are formed by the radius of the land. The driver land does not go below the pitch line but remains at this line until it meets the tooth space preceding the first tooth.

Small Mechanical Clutches for

Clutches used in calculating machines must have: Quick response—lightweight moving parts; (2) Flexibility—permit multiple members to

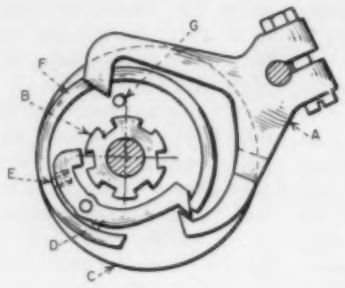


Fig. 1

PAWL AND RATCHET SINGLE CYCLE CLUTCH (Fig. 1). Known as Dennis Clutch, parts *B*, *C* and *D*, are primary components, *B*, being the driving ratchet, *C*, the driven cam plate and, *D*, the connecting pawl carried by the cam plate. Normally the pawl is held disengaged by the lower portion of clutch arm *A*. When activated, arm *A* rocks counter-clockwise until it is out of the path of rim *F* on cam plate *C* and permits pawl *D* under the effect of spring *E* to engage with ratchet *B*. Cam plate *C* then turns clockwise until, near the end of one cycle, pin *G* on the plate strikes the upper part of arm *A* camming it clockwise back to its normal position. The lower part of *A* then performs two functions: (1) cams pawl *D* out of engagement with the driving ratchet *B* and (2) blocks further motion of rim *F* and the cam plate.

PAWL AND RATCHET SINGLE CYLCLE DUAL CONTROL CLUTCH—(Fig. 2). Principal parts are: driving ratchet, *B*, directly connected to the motor and rotating freely on rod A; driven crank, *C*, directly connected to the main shaft of the machine and also free on A; and spring loaded ratchet pawl, *D*, which is carried by crank, *C*, and is normally held disengaged by latch *E*. To activate the clutch, arm *F* is raised, permitting latch *E* to trip and pawl *D* to engage with ratchet *B*. The left arm of clutch latch *G*, which is in the path of the lug on pawl *D*, is normally permitted to move out of interference by the rotation of the camming edge of crank *C*. For certain operations block *H* is temporarily lowered, preventing motion of latch *G*, resulting in disengagement of the clutch after part of the cycle until subsequent raising of block *H* permits motion of latch *G* and resumption of the cycle.

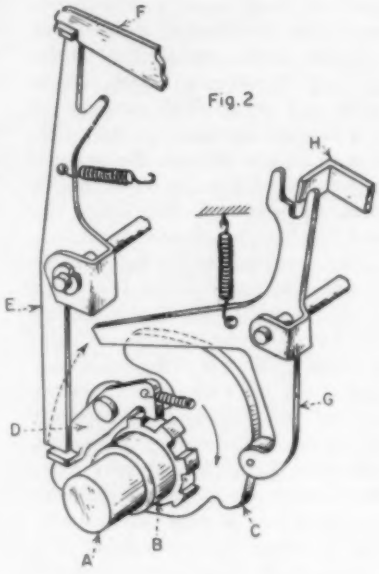
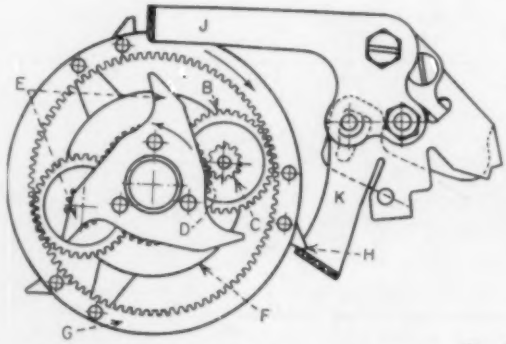
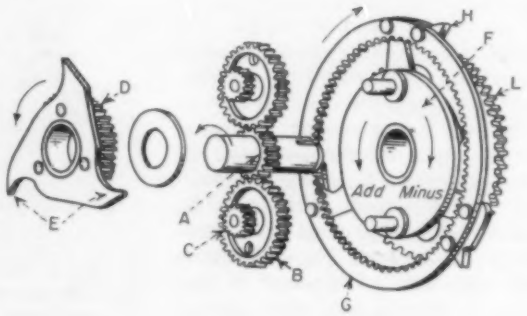


Fig. 2

PLANETARY TRANSMISSION CLUTCH (Fig. 3). A positive clutch with external control, two gear trains to provide bi-directional drive to a calculator for cycling the machine and shifting the carriage. Gear *A* is the driver, gear *L* the driven member, is directly connected to planet carrier *F*. The planet consists of integral gears *B* and *G*; *B* meshing with sun gear *A* and free-wheeling ring gear *G*, and *C* meshing with free-wheeling gear *D*. Gears *D* and *G* carry projecting lugs, *E* and *H* respectively, which can contact formings on arms *J* and *K* of the control yoke. When the machine is at rest, the yoke is centrally positioned so that the arms *J* and *K* are out of the path of the projecting lugs permitting both *D* and *G* to free-wheel. To engage the drive, the yoke rocks clockwise as shown, until the forming on arm *K* engages lug *H* blocking further motion of ring gear *G*. A solid gear train is thereby established driving *F* and *L* in the same direction as the drive *A* and at the same time altering the speed of *D* as it continues counter-clockwise. A reversing signal rotates the yoke counter-clockwise until arm *J* encounters lug *E* blocking further motion of *D*. This actuates the other gear train of the same ratio.



(a)



(b)

Fig. 3

Precise Service

MARVIN TAYLOR
Monroe Calculating Machine Company

control operation; (3) Compactness—for equivalent capacity positive clutches are smaller than friction; (4) Dependability; and (5) Durability.

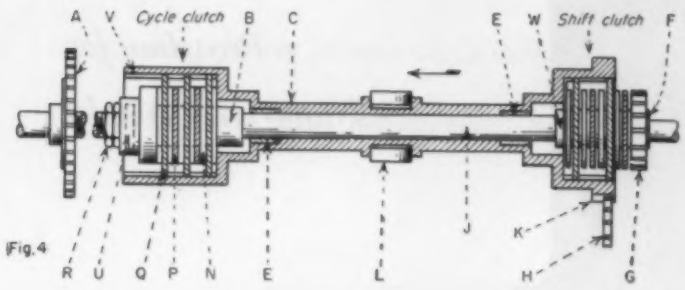


Fig. 4

MULTIPLE DISK FRICTION CLUTCH (Fig. 4). Two multiple disk friction clutches are combined in a single two-position unit which is shown shifted to the left. A stepped cylindrical housing *C* enclosing both clutches is carried by self-lubricated bearings *E* on shaft *J* and is driven by the transmission gear *H* meshing with the housing gear teeth *K*. At either end, the housing carries multiple metal disks *Q* that engage keyways *V* and can make frictional contact with formica disks *N* which, in turn, can contact a set of metal disks *P* which have slotted openings for coupling with flats on sleeves *B* and *W*. In the position shown, pressure is exerted through rollers *L* forcing the housing to the left making the left clutch compact against adjusting nuts *R*, thereby driving gear *A* via sleeve *B* which is connected to jack shaft *J* by pin *U*. When the carriage is to be shifted, rollers *L* force the housing to the right, first relieving the pressure between the adjoining disks on the left clutch then passing through a neutral position in which both clutches are disengaged and finally making the right clutch compact against thrust bearing *F*, thereby driving gear *G* through sleeve *W* which rotates freely on the jack shaft.

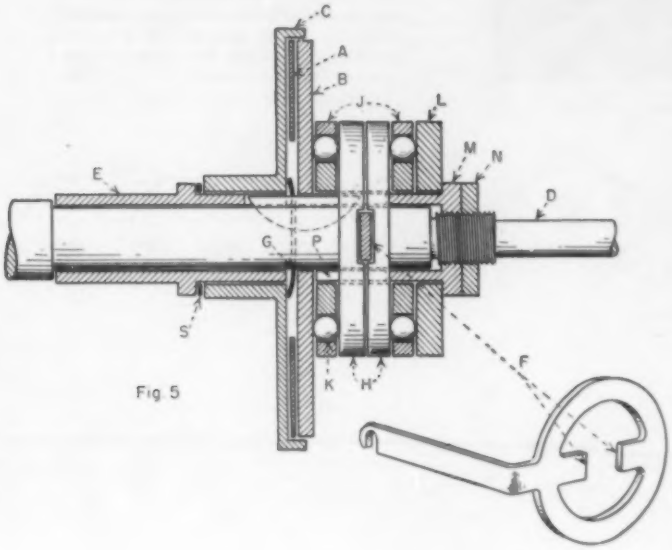


Fig. 5

SINGLE PLATE FRICTION CLUTCH (Fig. 5). The basic clutch elements, formica disk *A*, steel plate *B* and drum *C*, are normally kept separated by spring washer *G*. To engage the drive, the left end of a control arm is raised, causing ears *F*, which sit in slots in plates *H*, to rock clockwise spreading the plates axially along sleeve *P*. Sleeves *E* and *P* and plate *B* are keyed to the drive shaft; all other members can rotate freely. The axial motion loads the assembly to the right through the thrust ball bearings *K* against plate *L* and adjusting nut *M*, and to the left through friction surfaces on *A*, *B* and *C* to thrust washer *S*, sleeve *E* and against a shoulder on shaft *D*, thus enabling plate *A* to drive drum the *C*.

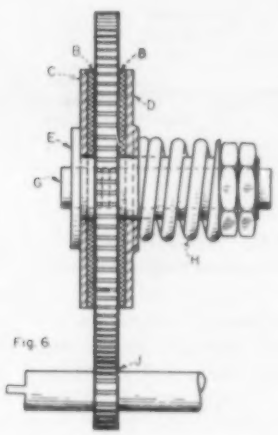
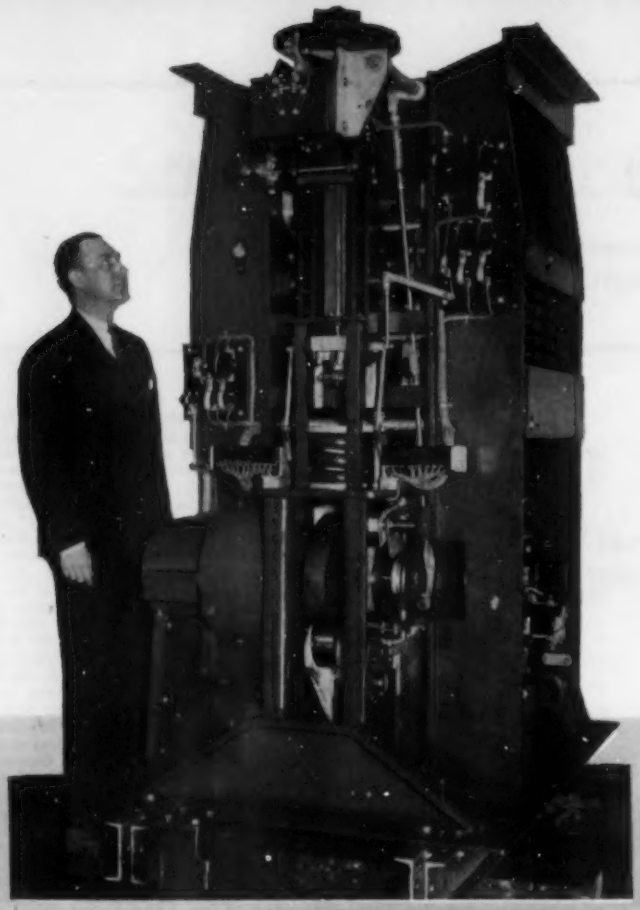


Fig. 6

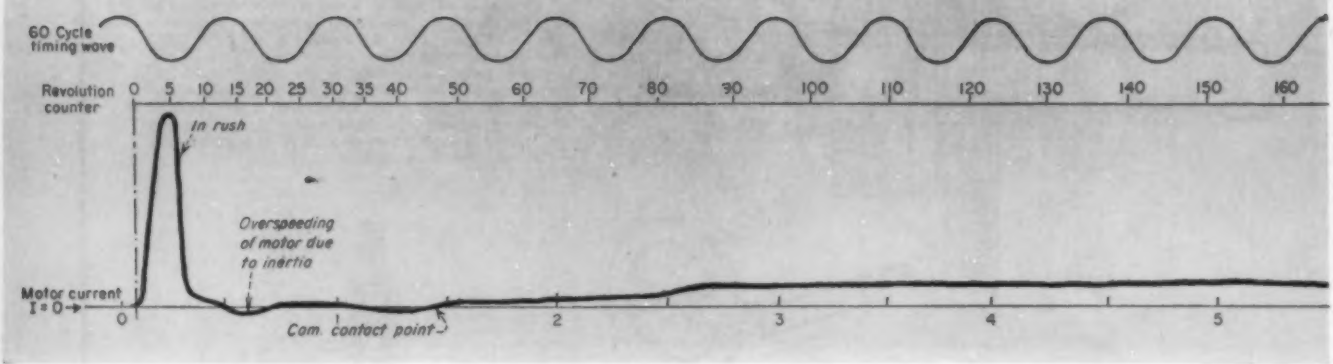
OVERLOAD RELIEF CLUTCH (Fig. 6). This is simple constructed, double-plate, spring loaded, friction coupling. Shaft *G* drives collar *E*, which drives slotted plates *C* and *D* and formica disks *B*. Spring *H* is forced by the adjusting nuts, which are screwed on to collar *E*, to maintain the unit under axial pressure against the shoulder at the left end of the collar. This enables the formica disks *B* to drive through friction against both faces of the gear which is free to turn on the collar, causing output pinion *J* to rotate. If the machine should jam and pinion *J* prevented from turning, the motor can continue running without overloading while slippage takes place between formica plates *B* and the gear.

Constant

- *Procedure for*
- *Numerical examples*



(Left) This 287,000 v, low oil content, high speed circuit breaker developed by the General Electric Company, Schenectady, N. Y., is operated by a spring-actuated mechanism. The spring is compressed by a constant torque cam. This application is a typical example of how


60 Cycle timing wave
Revolution counter
0 5 10 15 20 25 30 35 40 50 60 70 80 90 100 110 120 130 140 150 160
In rush
Overspeeding of motor due to inertia
Motor current I = 0
0
2
3
4
5
Cam contact point

CARL THUMIM
Lawson Machinery Corporation

CAMS ARE COMMONLY USED for obtaining desired motions, for timing, and for getting mechanical advantage. In most of these applications, the cam curve is determined either by the velocity or by the desired acceleration characteristics. Another application, equally useful but not so well known, is that of obtaining variable output forces while the input torque remains essentially constant. A system like this is useful in isolating the effects of fluctuating or cyclic loadings from the driving motor and gear boxes. Thus, obvious advantages are its smaller power unit, smaller transmission parts —such as gears—smaller overall size, and therefore, lower total cost.

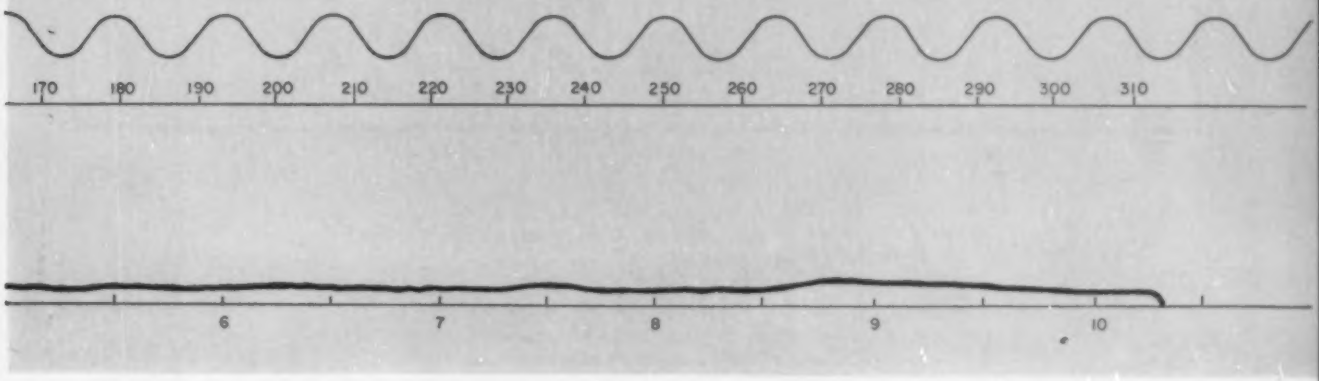
There are several possible methods for designing such a mechanism. The underlying principles are the same in all cases, but the details differ with various types of desired output characteristics. The basic steps are as follows:

1. Starting with the force-displacement curve of the required output, determine the total area under the curve. This equals the work to be done.
2. Divide this area and the total

Torque Power Cams

designing power cams—as distinguished from time-displacement cams. are included, and the analysis is extended to include friction.

such a cam can be used to reduce the size and, therefore, the cost of the driving motor. Only a three horsepower electric motor is required to compress the massive spring from 18,000 to 36,000 lb in a stroke of eight inches. This is accomplished in approximately 10 seconds. The simplified drawing shown below is based on an actual oscillogram that was taken to check the performance of the cam in a machine of this particular type. A 60 cycle timing wave and a revolution counter was used instead of a tachometer for accurate evaluation of the current characteristics. Note that after the cam contact point, the current curve which represents the input torque is quite flat; the sustained value was 11.5 amps. Individual values ranged from 9.5 to 12.2 amps. The total average motor speed for this test was 1,740 rpm.



angular travel of the cam into the same number of equal parts, thus defining the equal increments of work to be done for each corresponding increment of cam rotation.

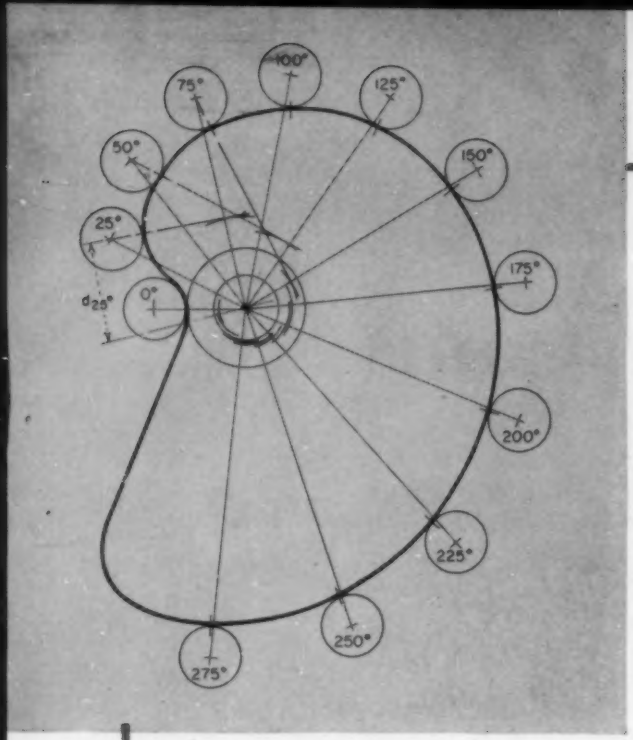
3. On the curve, find the coordinates that form the boundaries of the equal areas in terms of rise of the cam follower and the load.

4. From the total work, calculate the uniform input torque required.

5. From the torque and load, obtain the approximate moment arm of the load force at each increment of cam rotation.

6. Plot the shape of the cam, using the rise of the cam follower (Step 3) and the corresponding cam position as coordinates, taking into account the point of tangency obtained by plotting the line of action of the load normal to the moment arm that has been calculated in the previous step.

In the three examples that follow, the cam follower is a roller rising along a path intersecting the center of the cam radially. These were chosen to illustrate basic problems that frequently arise. The solutions all follow the procedure just outlined; only the details of analyzing the various curves differ. A final section shows how friction effects can be included.



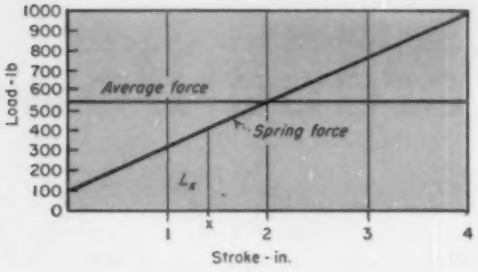


Fig. 1—Plot of spring load vs stroke is typical example of an output curve following Hooke's Law.

Fig. 2—Constant torque cam for cocking spring with load-displacement relationship shown in Fig. 1.

Table I—Design Data from Curve in Fig. 1, f=0

Cam Rotation Degrees	25	50	75	100	125	150	175	200	225	250	275
Area, In.-lb	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200
$4ac$ (−)	576	1,152	1,728	2,304	2,880	3,456	4,032	4,608	5,184	5,760	6,336
$b^2 - 4ac$	640	1,216	1,792	2,368	2,944	3,520	4,096	4,672	5,248	5,824	6,400
$x = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$	0.96	1.49	1.90	2.25	2.56	2.85	3.11	3.35	3.58	3.79	4.00
L_x	316	436	528	607	676	741	800	853	906	951	1,000
d	1.45	1.25	0.87	0.76	0.68	0.62	0.57	0.54	0.51	0 48	0.46

1. Output Curve Following Hooke's Law

A typical problem is one requiring the stressing of a spring by means of an electric motor. The usual solution is to use a screw for which the mechanical advantage does not change, and the input torque rises at a constant rate that is determined by the spring gradient.

The spring to be stressed is shown in Fig. 1, the load rises from 100 lb to 1,000 lb, in a 4 in. stroke. If a frictionless screw is used, the maximum torque can be expressed by $1{,}000K$ where K is a constant. But if a constant torque device is used, the torque has a uniform value of $550K$. Obviously, all forces and powers in the latter case are only 55 percent of those in the former, with resultant savings. Applying the general method above, the solution follows:

STEP 1. From the area under the curve, the total work is

$$4\left(\frac{100 + 1{,}000}{2}\right) = 2{,}200 \text{ in.-lb}$$

STEP 2. Assuming the cam is to rotate 275 deg while doing the work, both work and angular motion can be divided into 11 equal parts, with 200 in.-lb of work to be done every 25 degrees.

STEP 3. At any point of the stroke, x, the value of the spring force is:

$$L_x = 100 + \left(\frac{1{,}000 - 100}{4}\right)x = 100 + 225x$$

The value of x for the first increment of area is expressed by:

$$x\left(\frac{100 + (100 + 225x)}{2}\right) = 200$$

or

$$9x^2 + 8x - 16 = 0, \text{ and}$$

$$x = \left(\frac{-8 \pm \sqrt{64 + 576}}{18}\right) = 0.96$$

Thus, the spring force is:

$$L_x = 100 + (225)\,(0.96) = 316$$

Similarly, the sum of the first and second areas is:

$$x\left(\frac{100 + (100 + 225x)}{2}\right) = 400$$

Reduced to lowest terms,

$$9x^2 + 8x - 32 = 0$$

This indicates that the binomial coefficients a and b remain the same and that c changes by multiples of 16. The other values can be found in Table I.

STEP 4. The constant torque input, T, required to move the cam is balanced by a torque output consisting of the load, L_x, at any given point, x, multiplied by its arm, d. The constant torque can be evaluated as follows:

$$T \times 2\pi \times \text{cam deg}/360 = \text{work}$$

For the sample problem,

$$T = \frac{2{,}200 \times 360}{2\pi \times 275} = 459.5 \text{ lb-in.}$$

STEP 5. Since T is also the output torque at every point, an approximate value of the moment arm at every incremental area can be found from $d = T/L_x$. Values of d at 25 deg intervals are tabulated in Table I.

STEP 6. The shape of the cam shown in Fig. 2 is obtained by first laying in the rise, x, and then drawing a line from the center of the roller tangent to an arc of radius, d, whose center is the axis of the cam. The intersection of this line with the roller circumference gives the approximate point of tangency.

2. Output Following Curve of Known Equation

When the equation of the output curve is known, or when it can be found, the area of the curve can be obtained by integration. For the type of curve shown in Fig. 3, where y increases as x increases, the equation can be found by solving for the coefficients of

$$y = a + bx + cx^2 + dx^3 \ldots.$$

Coordinates taken from the curve are:

x =	0	0.9	1.2	1.6	2.1
y =	2	7	8	9	10

Substituting some of these values of x and y in the general equation, the following simultaneous equations ensue:

$x = 0, \quad y = 2; \quad a = 2$
$x = 1.2, \quad y = 8; \quad a + 1.2b + 1.44c = 8$
$x = 2.1, \quad y = 10; \quad a + 2.1b + 4.41c = 10$

Solving simultaneously,

$a = 2$
$b = 6.59$
$c = -1.33$

The equation of the curve then becomes

$$y = 2 + 6.59x - 1.33x^2$$

Using the general method, the design now proceeds as follows:

STEP 1. Integrating the equation to obtain the area under the curve,

$$\int_0^{2.1} \frac{d(y)}{dx} = 2x + \frac{6.59x^2}{2} - \frac{1.33x^3}{3}$$

Evaluating this integral for the given limits, the area equals 14.6 in.-lb of work.

STEP 2. Divide this area into 10 equal parts of 1.46 in.-lb and the cam travel of 300 deg into 10 corresponding arcs of 30 degrees.

STEP 3. The value of x bounding each incremental area can be found algebraically by equating the cubic

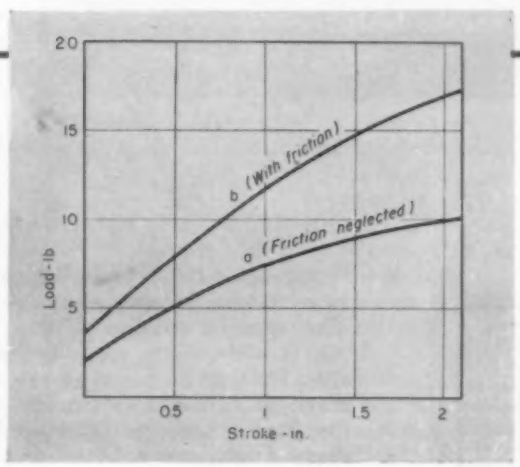


Fig. 3—Curve (a) is typical of Example 2, friction being neglected. To include friction, new curve (b) is calculated, and design continued as for zero friction.

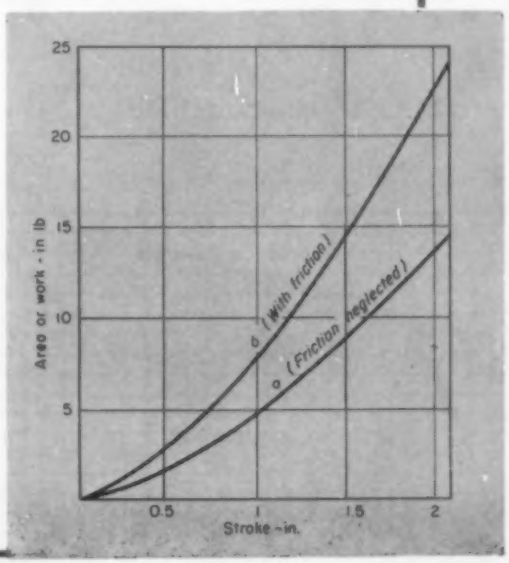
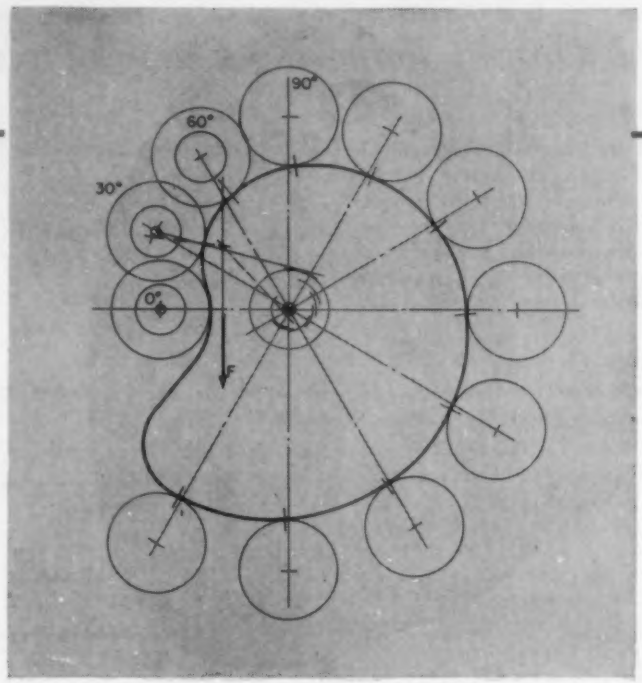


Fig. 4—Plot of area for curves (a) and (b) of Fig. 3.

Table II—Data for Fig. 3, f=0

Increment	1	2	3	4	5	6	7	8	9	10
Cam Travel, Deg.	30	60	90	120	150	180	210	240	270	300
Area, In.-lb	1.46	2.92	4.38	5.84	7.30	8.76	10.2	11.7	13.1	14.6
x	0.39	0.69	0.93	1.14	1.33	1.49	1.66	1.80	1.96	2.1
$6.59x$	2.57	4.55	6.12	7.50	8.75	9.80	11.0	11.8	12.9	13 9
$1.33x^3$	0.20	0.62	1.15	1.73	2.36	2.95	3.68	4.32	5.13	5.87
y	4.37	5.93	6.97	7.77	8.39	8.85	9.28	9.53	9.77	10 0
d	0.62	0.47	0.40	0.36	0.33	0.32	0.30	0.29	0.28	0 28

Fig. 5—Constant torque cam for curve of Fig. 3. At the 30 deg position of the follower, construction is modified to show how friction can be included. See Table IV.



equation to values of areas that vary by equal increments, or by plotting assumed values of x as shown in curve a of Fig. 4 and reading the coordinates which are shown in Table II.

STEP 4. The constant torque is

$$T = \frac{14.6 \times 360}{2\pi \times 300} = 2.775 \text{ lb-in.}$$

STEP 5. To find y at each incremental area, the corresponding value of x is inserted into the equation of the curve and tabulated. The value of the arm d is then obtained by dividing T by y.

STEP 6. The cam, Fig. 5, is then laid out by plotting the rise x at each increment of motion, and by determining the point of tangency as before.

3. Output Curves of Irregular Shape

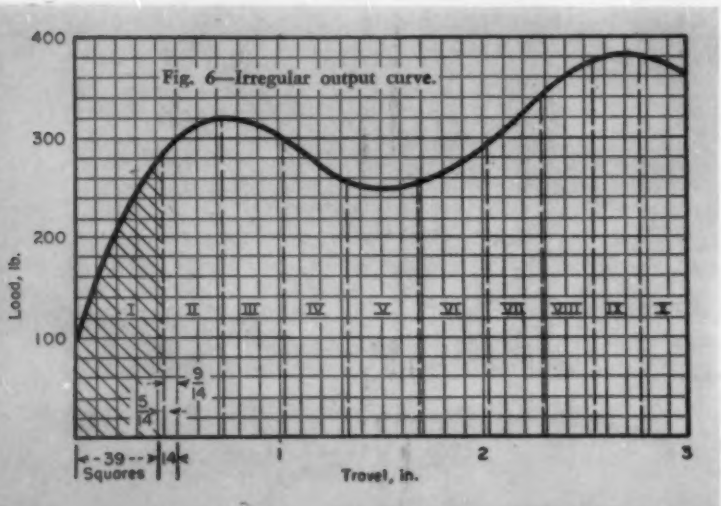


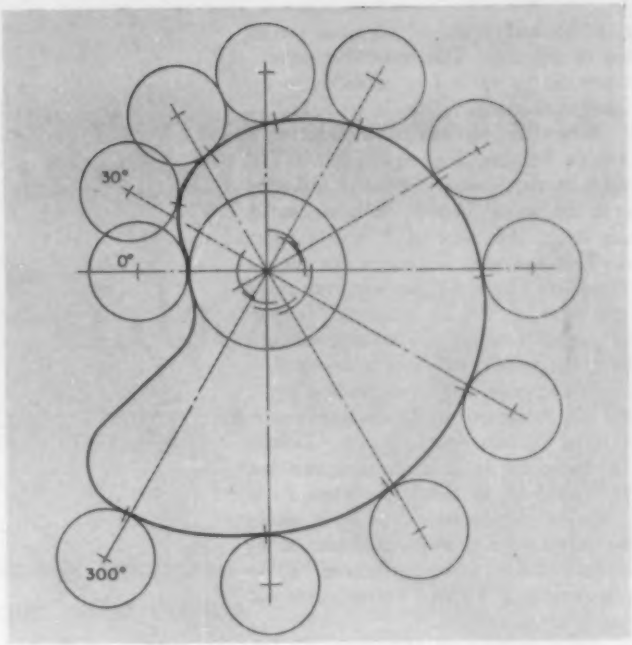
Fig. 6—Irregular output curve.

Although the shape of the force-travel curve can often be expressed as an equation, there are occasions, as shown in Fig. 6, where this is practically impossible. Here, the curve cannot be approximated satisfactorily with a usable equation. The solution can be obtained by counting the squares under the curve and then dividing the area into equal increments as before.

STEP 1. In the curve shown, the number of squares is found to be 438.

STEP 2. If the cam is to act in 300 degrees, both area and travel can be

Fig. 7—Constant torque cam for the irregular curve shown in Fig. 6. Details of constructing cone shape are identical to those of the two previous examples, with friction neglected. To include friction, see Fig. 3 and Fig. 8, below.



divided into ten equal parts corresponding to 43.8 squares and 30 degrees.

STEP 3. The area boundaries can usually be determined graphically with sufficient accuracy for practical use. However, care should be taken to prevent an accumulation of error. For example, in Area I of Fig. 6, the area under the curve after 0.4 in. of travel is equal to 39 squares. The next 0.1 in. of travel must then be divided to obtain the equivalent of 5 squares to get a total for Area I of 44 squares. Since this column of travel is equal to 14 squares, it is split vertically in the ratio of 5 to 9, the former being assigned to Area I and the latter to Area II. The same procedure is followed for each remaining increments.

STEPS 4-6. Essentially unchanged.

4. Analysis of Friction Considerations

In the examples discussed, all rubbing surfaces were assumed to be frictionless, which can be approximated by the use of anti-friction bearings throughout, including guides. In practice, however, this is too costly, and ordinary sliding bearings are usually used at the expense of some power loss.

The following method indicates how the effects of friction can be evaluated. The frictionless constant torque used in all the problems solved previously can be obtained graphically as indicated in Fig. 8(A), where L is the load on roller A and F is the applied force which provides the torque causing the cam to rotate counter-clockwise on shaft B. The value of F is found from force diagram Fig. 8(B).

If the coefficient of sliding friction is taken as 0.20 and applied to the equilibrium diagram, 8(C), as described in the article "Starting Friction in Mechanical Linkages", *Product Engineering*, October 1951, the value of F_f under friction conditions is found from force diagrams Fig. 8(D) to be considerably greater than that of F which is obtained by neglecting friction. The dotted portion of 8(D) indicates the magnitude of roller force, L_f, that would be necessary to get an applied force equal in magnitude to F_f, under conditions of zero friction.

Using the zero friction approach to the problem of Fig. 3, the input force F, obtained by the method outlined

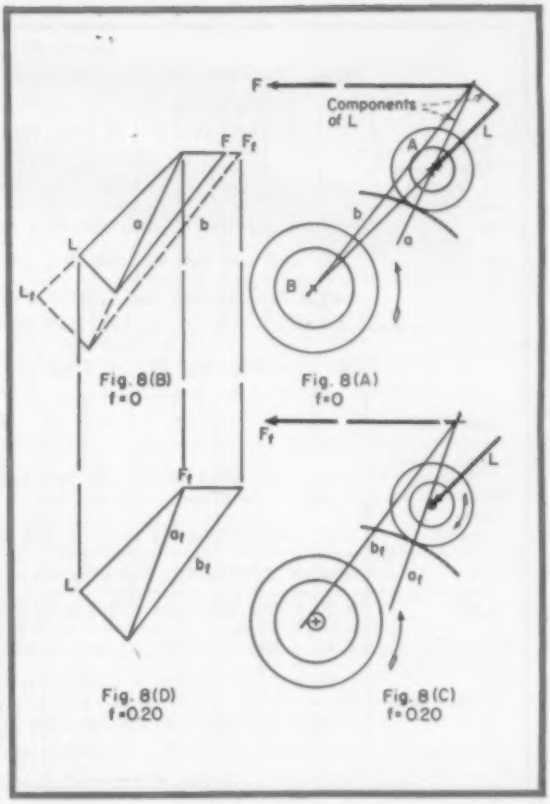


Fig. 8—Analysis of forces acting on a cam, showing comparison of magnitudes with and without friction.

in Fig. 8(A) and 8(B) is the same for all positions of the cam. This somewhat surprising feature can be verified by referring to the detail graphical analysis that is presented in Fig. 9. When the method of introducing a coefficient of friction, Fig. 8(C) and 8(D), is applied to the various positions indicated in Fig. 9, the input force F_f will, of course, be much larger than that of F with f taken at zero. This has been illustrated for the 30 degree position. In a similar way, values of F_f for all positions can be obtained. To permit the use of the "Step" method outlined previously, the values of F_f can be assumed to be the inputs required for corresponding larger output loads, designated as L_f, obtained under conditions of friction equal to zero. This is done by using the same force diagrams but working backwards to obtain L_f when F_f is given. The 30 deg location in Fig. 9 shows how this is done. Similarly, all values of F_f can be obtained and plotted as curve "b" in Fig. 3 to present a different output curve for solution.

From the coordinates of this curve the following equation can be written:

$$y = 3.5 + 9.67x - 1.46x^2$$

By integration, the area under the curve is found to be equivalent to 24.1 in.-lb. of work.

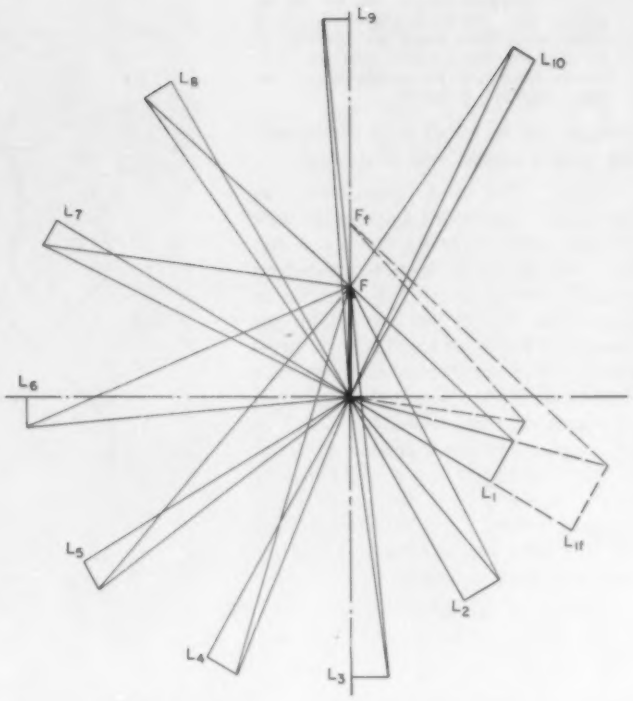


Fig. 9—Force diagram for the output curve of Fig. 3. The roller load at the 30 deg position is represented by L_2 for zero friction and L_{2f} with a coefficient of friction equal to 0.20.

Table III—Data for Fig. 6, f=0

Area	I	II	III	IV	V	VI	VII	VIII	IX	X
Cam Travel Degrees	30	60	90	120	150	180	210	240	270	300
x	0.43	0.72	1.01	1.33	1.68	2.02	2.29	2.54	2.77	3.00
L	280	320	298	254	256	290	345	376	382	363
d	0.60	0.52	0.56	0.66	0.65	0.58	0.48	0.44	0.44	0.46

Table IV—Data for Fig. 3, f=0.20

Increment	1	2	3	4	5	6	7	8	9	10
Cam Travel Degrees	30	60	90	120	150	180	210	240	270	300
Area In.-lb	2.41	4.82	7.23	9.64	12.1	14.5	16.9	19.3	21.7	24.1
x	0.42	0.71	0.95	1.14	1.32	1.48	1.66	1.82	1.99	2.1
$9.67x$	4.06	6.87	9.19	11.1	12.8	14.3	16.2	17.6	19.3	20.3
$1.46x^2$	0.27	0.72	1.32	1.80	2.55	3.22	4.02	4.85	5.70	6.23
y	7.29	9.65	11.4	12.8	13.7	14.6	15.7	16.8	17.1	17.6
d	0.64	0.48	0.41	0.36	0.34	0.32	0.29	0.28	0.27	0.26

Following all steps in order, the values obtained are shown in Table IV. The uniform torque is

$$T = \left(\frac{24.1 \times 360}{2\pi \times 300}\right) = 4.61 \text{ lb-in.}$$

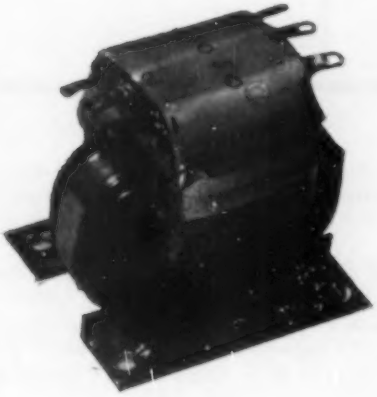
A comparison of the magnitudes of the x and d values in Tables II and IV indicates that the variations for the corresponding cam positions are comparatively small. In fact, the differences may be considered less than the discrepancies that will be introduced in constructing and scaling values from the force diagrams. Therefore, the cam outline for all practical values of friction would not differ materially from that obtained when friction is neglected. The main difference lies in the two values of the input torques, which are 2.77 lb-in. for $f = 0$ and 4.61 for $f = 0.20$.

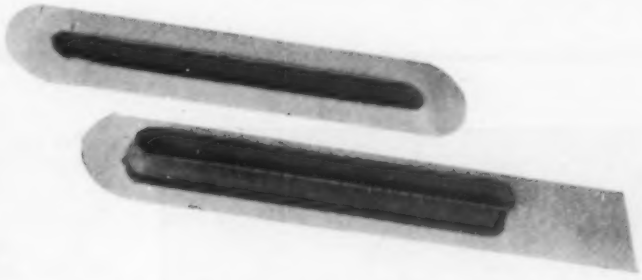
The calculation then need be carried only up to the point of obtaining the area under the curve when friction is considered. From this, the constant input torque with friction can be calculated. As pointed out previously, the delineation of the cam under frictionless conditions is accurate enough for all practical purposes. The constant input torque under friction conditions determines the upper limit of applied forces to be used for determining the size of parts used and for determining the power requirements.

Silicone Dielectric Materials

Combining excellent insulating properties throughout a wide temperature range during long periods of time with ease of handling in their various physical forms, these members of the silicone family are finding increased usage.

Life of coils in oil-filled circuit breakers is extended many times with Class H silicone insulation.





Silicone insulating resins and laminates permit appreciable savings in space and weight of electrical components such as coils, slot insulators, shaft collars and grommets.

D. F. CHRISTENSEN

Product Engineering Laboratories, Dow Corning Corporation

As ELECTRICAL insulating materials, silicones offer four advantages to the designer. Their use permits: (1) substantial reductions in space and weight, (2) longer service life, (3) reliability when exposed to temperature and moisture extremes, and (4) above-average mechanical and electrical abuse. These advantages stem from one property, heat resistance, which has long been a major handicap of dielectric materials.

Whether the silicone is a resin, fluid or rubber, many properties are common to all forms. All have good dielectric properties, all are highly water repellent, and all can be used throughout a temperature range, that is broader than for comparable organic materials.

In formulating the various silicone compounds, it was necessary to recheck electrical classifications for insulating materials. In 1947, the AIEE established Class H for heat resistant insulation as consisting of inorganic materials bonded with silicone compounds or materials with equivalent properties. A "hot spot" temperature of 180 C was set for this classification. The Navy have since raised this figure to 200 C in their specifications.

By comparison, AIEE Class A insulation is made up of organic components bonded with organic varnish and has

Table I—Typical Properties of Silicone Insulating Resins and Varnishes

Property	Coating Resins			General-Service Dipping Varnishes**	
	Low Temp Service 935*	General Service** 994	High Temp Service 993	Medium Cure 996	Fast Cure 997
Solids Content, percent	50	50	50	50	50
Color	Light Straw	Light Straw	Light Straw	Light Straw	Dark brown
Spec Gravity at 250 C	1.00–1.02	1.00–1.02	1.00–1.02	1.00–1.02	1.00–1.03
Viscosity at 25 C, centipoises	80–150	80–125	100–200	100–200	100–200
Drying Time, max	1 hr at 250 C	1 hr at 250 C	3 hr at 250 C	3 hr at 150 C	3 hr at 200 C
Flash Point, F	70–90	70–90	70–90	70–90	70–90
Weight Loss, percent (after 3 hr at 250 C)	5	7	7	4	5
Craze Life, minimum (hr at 250 C)	800	3,000	1,000	750	1,000
Flex Life Minimum (hr at 250 C)	100	1,000	250	250	250
Dielec Strength, v/mil (2-in. electrodes)	1,000–2,000	1,600–1,900	1,000–1,500	1,000–2,000	1,000–2,000
Solvent	Xylene	Xylene	Xylene	Xylene	Xylene
Recommended Thinners	Xylene, toluene, high-flash naphtha	Aromatic hydrocarbons	Xylene, hydrocarbon solvents	Xylene, toluene, hydrocarbon solvents	Xylene, toluene, hydrocarbon solvents

* Dow Corning Stock Numbers.
** For ordinary applications at 350 to 500 F.

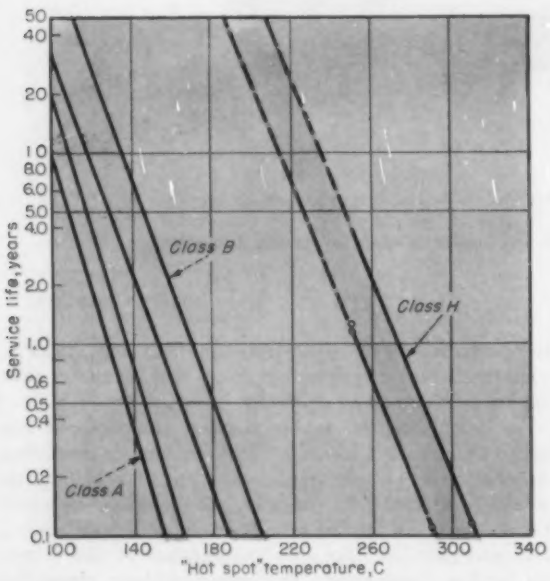


Fig. 1—Life expectancy of Class A, B and H insulations at various "hot spot" temperatures. According to 10 deg C "rule", Class H material at 200 C will last in excess of 50 yr. This temperature conforms to Navy specifications.

a "hot spot" rating of 105 C. Class B insulation consists of inorganic components bonded with an organic varnish, or equivalent material, and has a "hot spot" rating of 130 Centigrade.

An estimate of thermal life for electrical insulation can be made according to the 10 deg C "rule", where each 10 deg C rise in temperature halves insulation service life. According to this industry-wide parameter, which is illustrated in Fig. 1, Class H insulation at 200 C should last at least 50 years.

SILICONE VARNISHES

These can be classified according to distinctive types as coating resins, dipping and impregnating varnishes, glass served magnet wire varnishes, bare magnet wire enamels, and laminating varnishes. Typical properties for the leading members of each type are given in Table I. Fig. 2 compares the thermal life of the dipping varnishes and cloth coating resins with that of Class B materials.

The silicone coatings are applied to glass cloth or a combination of glass cloth and mica. Similarly, they are sprayed on purified asbestos to achieve additional strength and moisture resistance. There are also combinations of these materials such as silicone varnish glass and silicone treated

Glass-Served Magnet Wire Varnish 1089	Bare Magnet Wire Enamel 1360
40	49
Dark amber	Dark amber
1.05–1.10	1.13–1.14
500–1,000	4,000–6,000
3 hr at 150 C	1 hr at 150 C
90	200
23	10
.....	...
.....	...
1,500	...
Cresylic acid, xylene	Cresylic acid
Cresylic acid, xylene, aromatic hydrocarbons	Cresylic acid, xylene, aromatic hydrocarbons

Table II—Typical Properties of High and Low Pressure Silicone Laminates

Property	High Strength		High Dielectric
	2103*	2104	2105
Laminating Pressure	High	Low	High
Cloth Style	112	181	112
Flexural Strength, psi			
At 77 F	27,000-32,000	37,300	37,000
After 200 hr at 500 F	17,600	12,000	8,100
Water Absorption, percent	1.0–1.3	0.20	0.05
Dielectric Strength, v/mil (1/8-in. section)			
As received	300	200–250	285
After 200 hr. at 500 F	80–100	51	364
Power Factor at 10^5 cps			
Condition A**	0.0022	0.0014	0.0019
Condition D***	0.0089	0.0060	0.0044
Arc Resistance, sec	350	275	260
Dielectric Constant at 10^5 cps			
Condition A**	4.13	3.44	3.31
Condition D***	4.50	3.56	3.31

* Dow Corning Stock Numbers
** Condition A — As received
*** Condition D — After 24-hr immersion in distilled water at 23C

asbestos, cemented together to form a composite material. Many glass-mica combinations have found wide use in the electrical industry because of the properties imparted by the coating resins. Glass sleeving and tubing so coated are characterized by flexibility and good dielectric strength, as well as high heat and moisture resistance.

Manufacturers of magnet wires have turned to silicone resins for bonding glass serving to meet Class H specifications. Similarly silicone magnet wire enamel has made it possible to save space with enameled wire which has the same diameter as Class A organically finished wires, but with greatly improved heat resistance characteristics. Tests are under way to determine whether this is a true Class H material. If so, this advancement will mean greater latitude in design and resulted in the development of high temperature miniature and sub-miniature equipments.

Properties of the principal silicone resins specifically formulated for high and lowpressure silicone laminates are listed in Table II. These rigid materials are available from most of the manufacturers of organic laminates and fall into two general classifications: continuous filament or staple Fiberglas. Both are bonded under heat and pressure with silicone resins.

The laminates not only have the high temperature characteristics of silicones, but also excellent dielectric properties

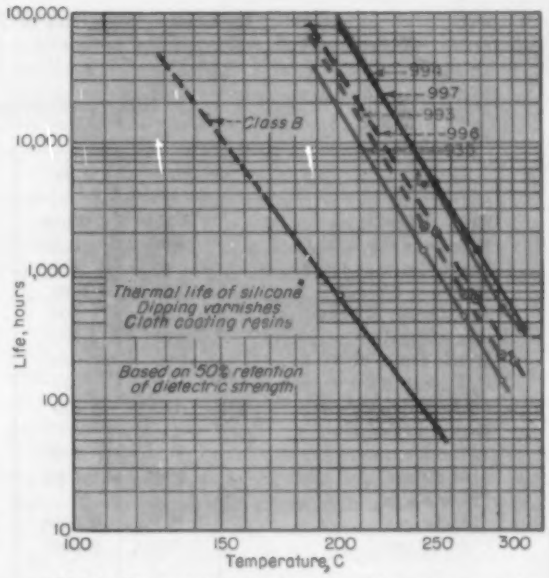


Fig. 2—Thermal life of silicone coating resins and dipping varnishes (see Table I for properties) compared to Class B insulation. Number references correspond to standard materials formulated by Dow Corning Corporation.

throughout a wide frequency range. Water absorption is low, resistance to arcing and tracking high. Those made with staple fiber cloth are easier to machine because of their greater bond strength, while continuous filament laminates have greater flexural strength and better electrical properties.

Of the high-pressure resins covered in Table II, type 2103 is best known, while 2105 is a recently-introduced material having improved dielectric properties. The 2104 resin is designed for laminating at low pressures ranging from 30 down to 3.0 psi. The properties of this material vary according to the cure. A short cure produces an excellent dielectric, while a long cure produces a rigid, light-weight material capable of withstanding short-time exposures at temperatures as high as 1,000 Fahrenheit.

Complex electrical insulating parts difficult to machine from laminate are frequently compression or transfer molded from silicone molding compounds. Of the several available compounds, most contain chopped glass fibers for added impact strength. Switch parts, brush ring holders and coil forms molded from these materials exhibit remarkably low moisture absorption, as well as good physical and electrical properties after long service at Class H levels.

SILICONE RUBBERS

This type of silicone dielectric combines all of the heat stability and moisture resistance of resinous silicones with many of the desirable properties of rubber, and adds a few features of its own. Its thermal conductivity is about 150 percent that of either resinous or organic rubber dielectrics. As cable covering, it has excellent resistance to corona; on ignition wire, it shows no deterioration after 12,000 hr under severe corona test conditions that cause organic rubber covering to fail in less than 30 minutes.

As indicated in Table III, the dielectric properties of typical silicone rubber stocks compare favorably at room temperature with those of conventional rubbers. The effect of increased temperature is seen in Fig. 3, where little change is indicated over a temperature span from below zero to above 200 C. This contrasts with organic stocks that deteriorate rapidly at elevated temperatures until they become conductors rather than dielectrics. Also of importance is the fact that high temperature aging does not significantly alter the dielectric properties of the silicones.

Silicone rubber has high resistance to arcing and electrical fatigue. The water absorption values of various stocks range from six percent to as low as 0.5 percent; only after long exposure under maximum absorption conditions is there any effect on dielectric properties. Other desirable characteristics include excellent resistance to ozone, sunlight and general outdoor weathering; good resistance to liquid dielectrics of the chlorinated biphenyl type and a remarkable resistance to extremely low temperatures. The ASTM brittle points range from —70 to —130 Fahrenheit.

A few of the current uses for silicone rubber are molded or extruded capacitor and transformer bushings; high temperature insulated wire, cable for ignition harnesses, motor and transformer lead wire, Navy control cable; and Silastic-coated glass cloth tapes for use in power cable and motor coils.

The wire and cable applications will expand in many fields among which are insulated power cable for use in central stations, household wiring and appliances. As hookup wire for electronic circuits, it would provide the required dielectric properties and resistance to high and low temperatures, moisture and weathering. At the same time, it would make equipment assembly easier because of its resistance to soldering iron temperatures.

Table III—Properties of Typical Silicone Rubber Stocks

Property	High Tensile Strength			Extreme Low Temperature		Low Comp Set, Low Temp	Caulking Paste
	50*	80	152	240	250	675	122
Color After Curing	White	White	Red	Translucent	Orange-tan	Red	Gray
Spec Grav (25 C/25 C)	1.25	1.25	1.2	1.2	1.2	1.3	1.5
Hours Cured at 482 F	24	24	24	24	24	24	4
Hardness, Shore A	52	80	50	42	48	70–80	90
Avg Tensile Strength, psi	900	800	800	600	625	600	630
Avg Elongation, percent	300	200	330	265	330	175	40
Brittle Point, F	—80	—80	—80	—130	—130	—130	—70
Compression Set,** percent	35	30	60	56	50	18	85
Dielec Strength, v/mil	571	579	350	400	400	550	450
Dielectric Constant,							
At 10^3 cps	3.11	2.95	2.9	3.11	3.4	3.07	3.6
At 10^6 cps	3.07	2.92	2.9	3.00	3.2	3.05	3.2
Power Factor							
At 10^3 cps	0.00360	0.0006	0.0015	0.003	0.004	0.0032	0.020
At 10^6 cps	0.00204	0.0007	0.0010	0.004	0.010	0.0014	0.006

*Dow Corning Silastic Stock Numbers

** Fully cured stock compressed for 22 hr at 302 F.

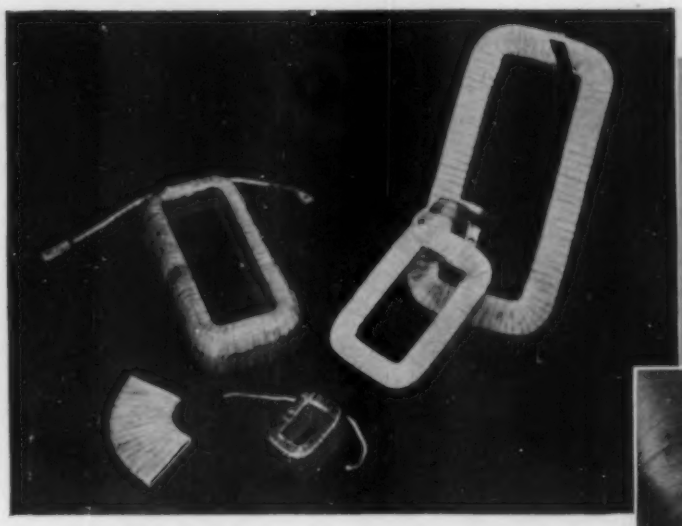


Fig. 4—Coil jackets of cured Silastic R tape are tough and resilient, as well as highly resistant to moisture lubricating oils and various chemicals.

Fig. 5—Printed circuits etched on copper-clad silicone-rubber-coated glass cloth are simple to install in electronic equipment used at high temperatures.

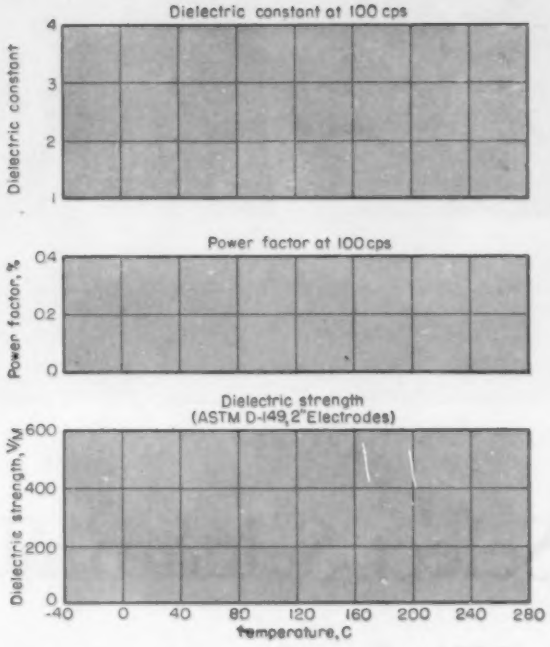


Fig. 3—Effect of temperature on dielectric constant, power factor and dielectric strength of ¼-in. Silastic 250 sheet.

SILICONE FLUIDS

Although these fluids are too expensive for general use in large liquid-filled electrical units, they have found wide application in small, high-temperature military equipment where size and weight are of prime importance. These include aircraft transformers, capacitors, and sealed electronic assemblies.

The silicone fluids as typified by Dow Corning 200 Fluid are water white, crystal clear liquids, which are available in a wide range of viscosities. They possess the same resistance to extreme temperatures that is characteristic of other silicones. In addition, they are not solvents and, as such, exhibit minimum softening and plasticizing action on other insulation materials.

In certain types of electronic equipment, silicone fluids are used as circulating heat transfer media where low freezing point, high temperature resistance and high dielectric strength are essential.

SPECIAL SILICONE COMPOUNDS

The well-known DC-4 Compound developed at the beginning of World War II is still in use as a waterproofing compound in aircraft ignition systems and AN connectors. Its properties are essentially similar to the DC 200 fluids, except for physical appearance and a texture similar to that of petrolatum. This silicone compound is proof against melting at high temperatures and stiffening at low temperatures.

Other special silicone compounds are used as lubricants for switches and contacts; as water repellent treatments for leather in linesmen's gloves; as lubricants for motor bearings; as protective coatings and identification markings on high temperature motors; and as resistor coatings.

Acknowledgments: Recognition is hereby made of the valuable assistance rendered by C. L. Christiansen, J. H. O'Neil and R. E. Bright, all of Dow Corning Corporation.

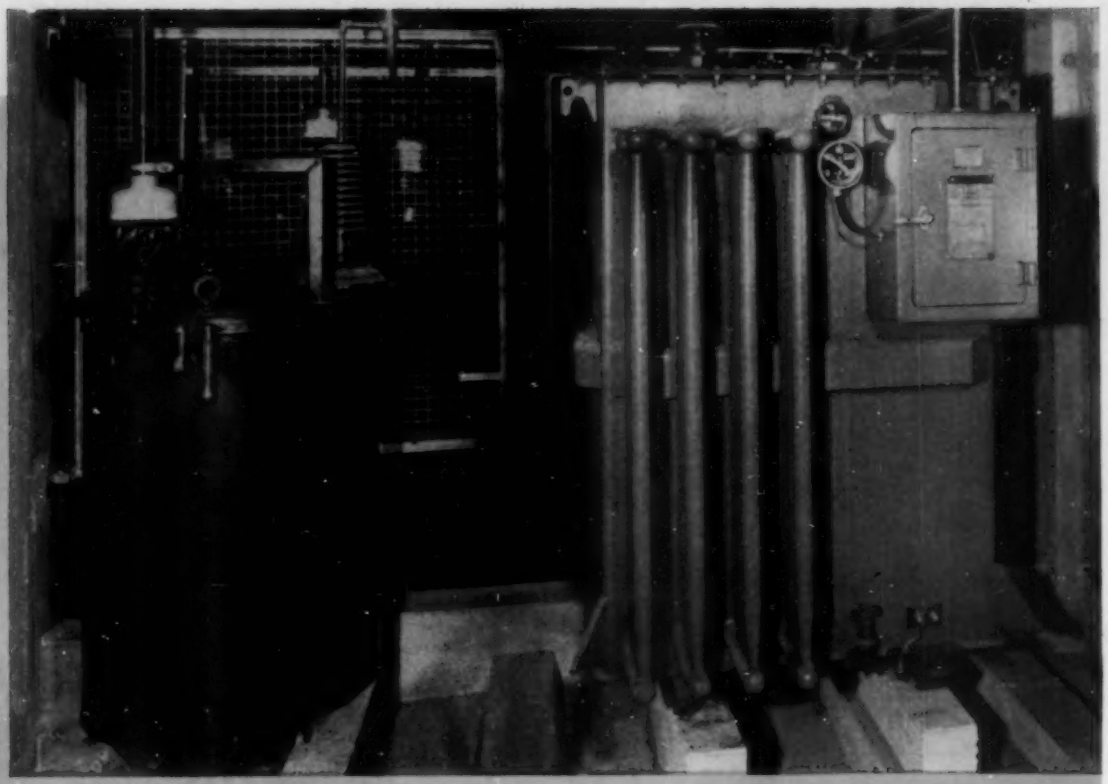


Fig. 1—Industrial oil immersed rectifier (middle) with transformer and circuit breaker. Unit is rated at 70 KV and is used for dust precipitation. Similar special rectifiers are available with voltage outputs from 35 to 75 KV. Power capacities range from 6 to 15 KV. Cleaning the air is necessary in some plants.

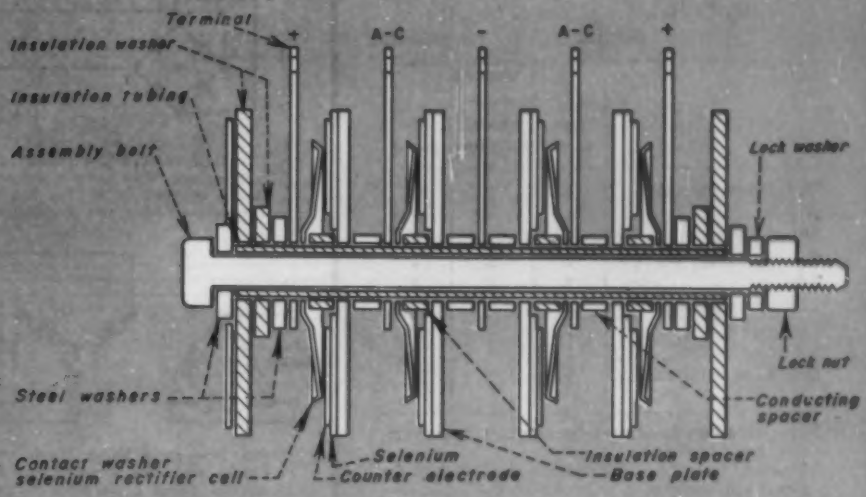
How to Select Selenium for High Capacity

H. D. JAMES
Consulting Engineer

SELENIUM RECTIFIERS have superceded other types of rectifiers for most industrial applications because of the following characteristics: (1) Thirty volt per cell rating available in commercial units; (2) Light weight; fabricated on aluminum plates; (3) High temperature operation does not cause excessive aging; (4) Good control of "starting material" in manufacture; (5) Will self-heal small shorts across the barrier layer.

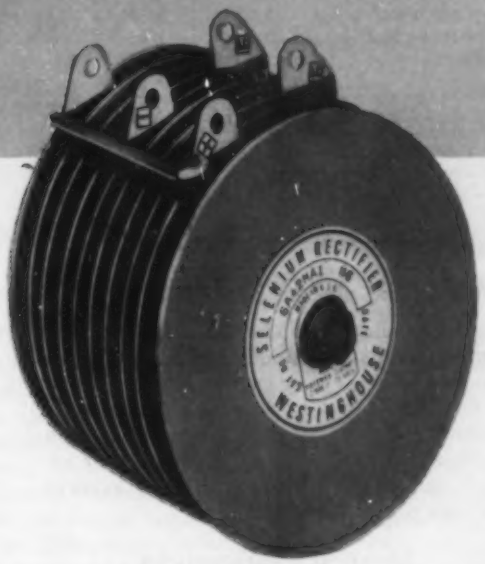
A comparison of properties of the various types of metallic rectifiers is shown in Table I. While the selenium rectifier is not superior in all classifications, the characteristics listed above make it most suitable for such applications as individual machine d-c supply, motor control, dust precipitation and voltage and frequency regulation.

Both magnesium-copper sulphide and selenium rectifiers are used in applications such as battery charging and electric welding, depending on the requirements of the particular design. Devices such as railway signals and



Cross-section of selenium rectifier. Terminals are provided for bolted or soldered connections. Unit can be supplied with or without mounting bracket. Insulating varnish coating protects against humidity and mildly corrosive atmospheres usually found in industrial locations.

Fig. 2—External view of typical selenium rectifier stack. Standard and wide cell spacings are available depending on rating and the factor of safety.



Rectifiers Applications

meters use copper oxide rectifiers since this type will retain its rectification ratio indefinitely under stand-by conditions, and the knee of the forward characteristic occurs at a low voltage. Selenium deforms during long idle periods and may take 60 cycles to completely reform.

The number of rectifier applications in general, and particularly of the selenium type, have been increased by the trend toward individual d-c power supplies for production machines and the use of magnetic amplifiers.

While a-c induction motors are the most satisfactory means of driving constant speed loads, d-c motors are superior for adjustable speed drives. Whether these motors are controlled by electronic speed regulators, armature or field control, or magnetic amplifiers, a source of d-c is required. In any circuit using magnetic amplifiers, rectifiers are required to obtain the self-saturating characteristic and prevent half-cycle demagnetization.

Selenium rectifiers are commercially available in sizes

Table I—Relative Merits of Metallic Rectifiers

	Copper oxide	Magnesium-copper sulphide	Selenium
High temp. operation	3	1	2
Weight	2	3	1
Efficiency*	1	2	1
Reverse voltage per cell	2	3	1
Life	1	2	1
Temporary overload-			
voltage	1	3	2
current	2	1	3
Deforming while idle	1	3	2

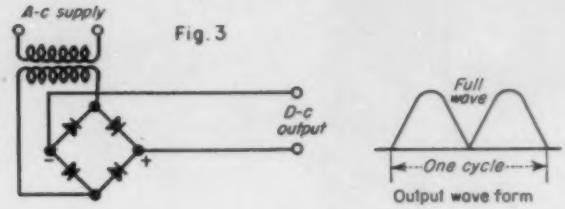
Note: Numbers indicate relative merit with number 1 highest.
* Depends on voltage. Selenium usually is best for power applications.

Table II—Current Multipliers for Rectifier Connections

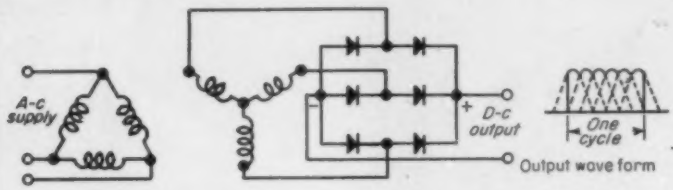
Type of connection	Multiplier	Refer to Fig. No.
Single-phase bridge	1.0*	3 (A)
Three-phase bridge	1.5**	3 (B)
Six-phase star	1.8**	3 (C)
Wye	1.33**	3 (D)

Note: Taken from NEMA Standards for Metallic Rectifiers.
* Working into resistive or inductor load.
** Working into any type of load.

Fig. 3

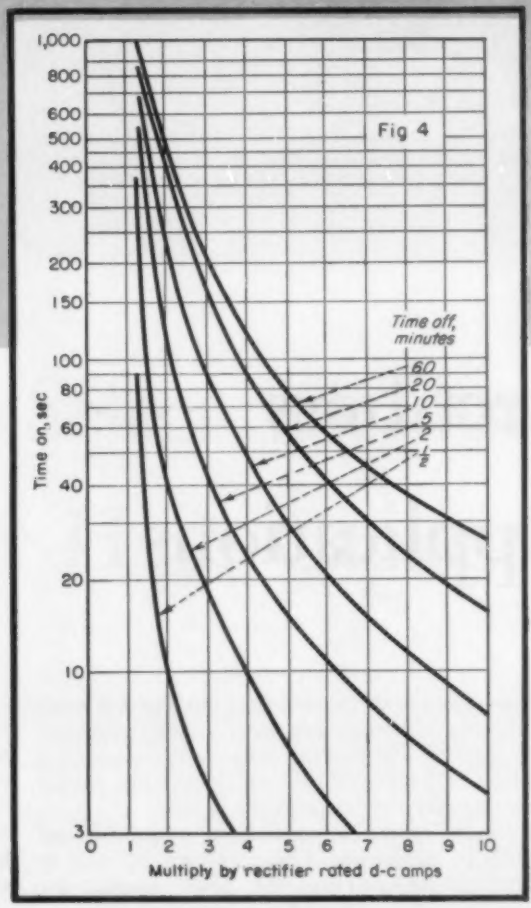


(A) Single-phase bridge circuit using four half-wave stacks operating into a resistive load. Most common arrangement for metallic rectifiers, usually used in control applications. It gives best transformer utility, or can be used without a transformer when voltage requirements are suitable.



(B) Three-phase bridge circuit using six half-wave stacks operating into a resistive load. Best rectifier circuit for power applications up to 50 hp since it supplies smooth d-c. Output d-c voltage almost equals a-c input voltage.

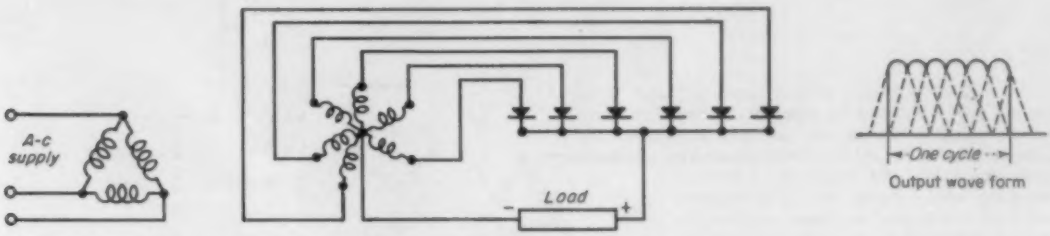
Fig 4



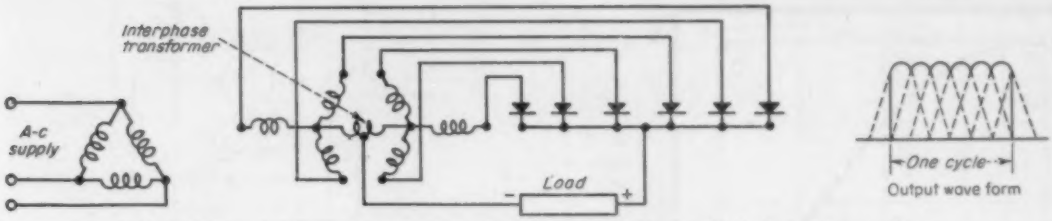
that will handle up to 50 hp, 230 volt d-c motors. Larger capacities are considered special; with high horsepower motors using ignitron rectifiers instead of metallic. Special mechanical features can be obtained with selenium units to permit operation under unusual environmental conditions: for example, oil immersed rectifiers for dusty locations and high voltage operation.

Electrical Characteristics

A rectifier is a device for converting a-c to pulsating d-c by suppressing the reverse flow of a-c during each half cycle. Depending on the allowable d-c pulsation, type of a-c supply and load requirements, there are many basic circuits used with all types of rectifiers. The most common of these are shown in Fig. 2 together with recommendations on their use. Table II lists the ratio of current capacity for each circuit based on a



(C) Six-phase star circuit operating into resistive load. Normally used with high capacity ignitron rectifiers; however, selenium rectifiers are sometimes used where central rectifying units supply d-c power to several production machines.



(D) Double-wye circuit operating into resistive load. Similar applications to the six-phase star connection.

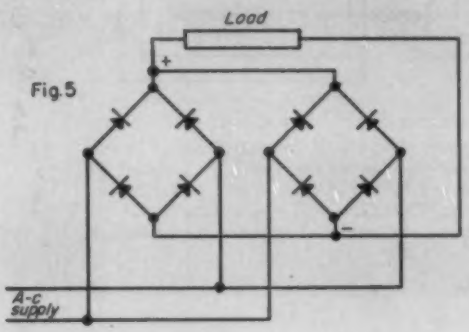


Fig. 3—Basic circuits for metallic rectifiers.

Fig. 4—Allowable overload factors for selenium rectifiers. Curve is based on a-c interruption during off period so that unit is not operated on open circuit. Rectifier current capacity for specific duty cycle is determined by multiplying the abscissa by the nominal rectifier rating in amperes.

Fig. 5—Parallel connection of two single-phase rectifier bridges. Becausse of the relatively high cost, this arrangement of rectifier circuits is only used when current requirements cannot be handled by the largest available cell.

capacity of one for the single-phase bridge connected circuit, Fig. 3 (A).

In a similar manner, the ratio of supply a-c voltage to output d-c voltage also varies with the type of circuit so that input transformers are usually required to obtain the desired output voltage for a given input voltage. For example, in a single-phase bridge an a-c input of 130 volts will yield approximately 105 volts d-c output, while the same input to a three-phase bridge will give approximately 260 volts.

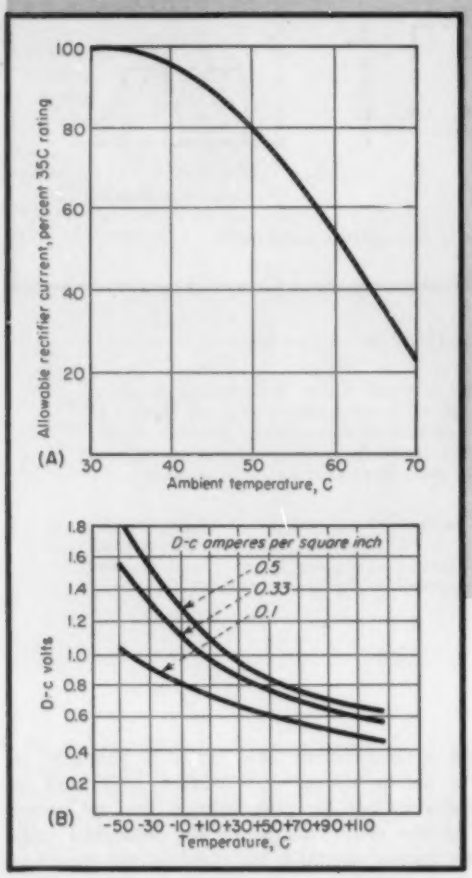
Once the proper basic circuit arrangement has been determined, rectifier selection depends on such factors as load and duty cycle, parallel or series connection and capacity, and temperature limitations.

Load and duty cycle. Selenium rectifier size is determined in the same way as motor size. The power input to the load is approximated and a curve plotted if the load is intermittent. For constant loads under normal ambient conditions, the size of rectifier can be selected from a manufacturer's table of ratings.

Overload in intermittent duty cycles is permitted in current but not in voltage and sufficient cells must be used in series so that the peak voltage does not exceed the sum of the rated voltages of the individual cells. Intermittent current overloads are based on not exceeding a temperature rise of approximately 40 C. Fig. 4 shows allowable overload factors, based on the duration of the load for various lengths of off time. In certain applications, these ratings can be increased by forced cooling of the rectifier stack.

Parallel or series connection. As stated previously, selenium cells are connected in series so that the peak voltage applied to a stack of cells does not exceed their total voltage rating. This is important since the rectifier passes current on only one-half cycle of a-c supply and must resist the reverse flow with ideally an infinite resistance on the other half cycle. Actual rectifiers do not have an infinite reverse resistance and allow a small leakage flow in the reverse direction. This is ignored in most high power industrial

Fig. 6—(A) Reduction in selenium rectifier current carrying capacity for ambient temperatures above 35 C. This curve applies for continuous loads. (B) Variation of forward resistance with temperature. With negative resistance coefficient, resistance decreases as rectifier temperature increases.



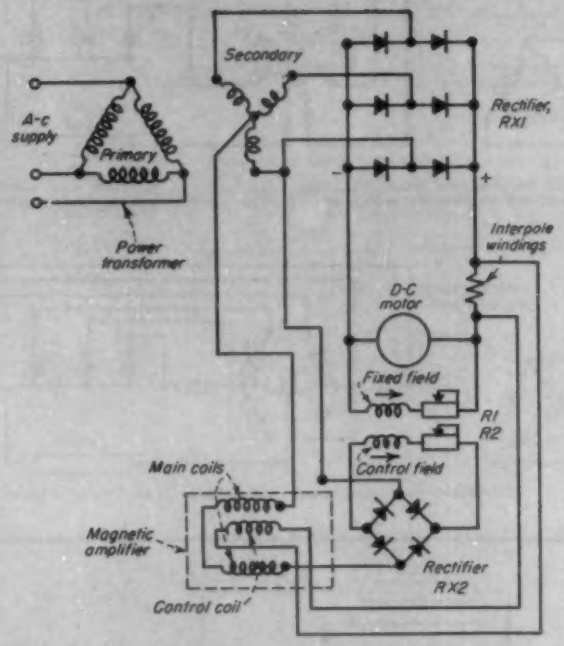


Fig. 8—Schematic diagram of constant load d-c motor with field control. Main motor power is supplied by three-phase bridge, *RX1*, and control field power by single-phase bridge, *RX2*. Note that single-phase power can be tapped from one phase of transformer secondary.

applications; however, a series of cells must be able to withstand full a-c potential on alternate half cycles without breaking down.

If possible, parallel connections are avoided since it is more economical to go to larger cells than to use additional cells in parallel. However, where the required current is greater than the current carrying capacity of the largest available cell, parallel connections must be used. To parallel rectifiers, complete basic circuits are paralleled. For example, Fig. 5 shows two bridge circuits in parallel. Similar arrangements are used to parallel the other basic rectifier circuits that are shown in Fig. 3, pages 194 and 195.

Temperature limitations. Temperature limits are closely associated with load and duty cycle since rectifiers are thermally rated devices. When operated within their rating and at temperatures below 35 C (95 F), selenium rectifiers have good life and efficiency characteristics and do not exhibit excessive aging. Operation under higher ambient conditions or under heavy overload conditions can cause damage and excessive aging. Normally, when high ambient temperatures are expected, the current rating of selenium rectifiers is decreased in accordance with the curve shown in Fig. 6(A).

The forward resistance of selenium rectifiers also varies with temperature and to some extent with time (aging). This type rectifier has a negative temperature coefficient of resistance; that is, the resistance decreases as temperature increases, Fig. 6(B). Aging causes a slight increase in forward resistance with time. If the load is sensitive to voltage variation, an autotransformer may be required to maintain the exact d-c voltage over a long period of time; however, tests have shown a forward aging of only 10 to

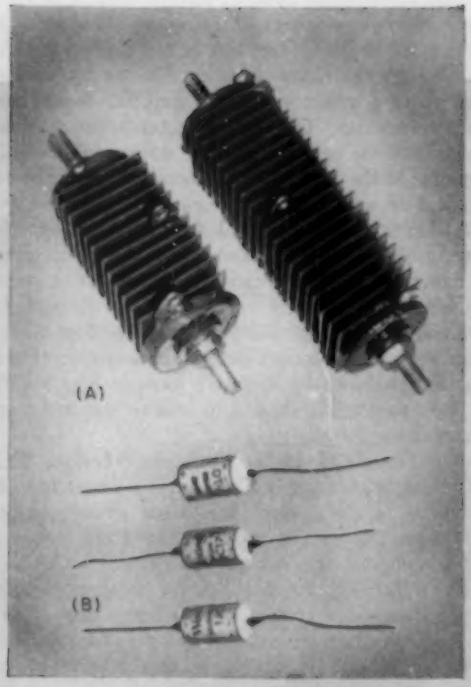


Fig. 7—Small selenium rectifiers for instrument applications. Units in (A) are similar to larger industrial models, while sealed units in (B) are pigtail mounted in low power electronic circuits. Stacks are bracket mounted.

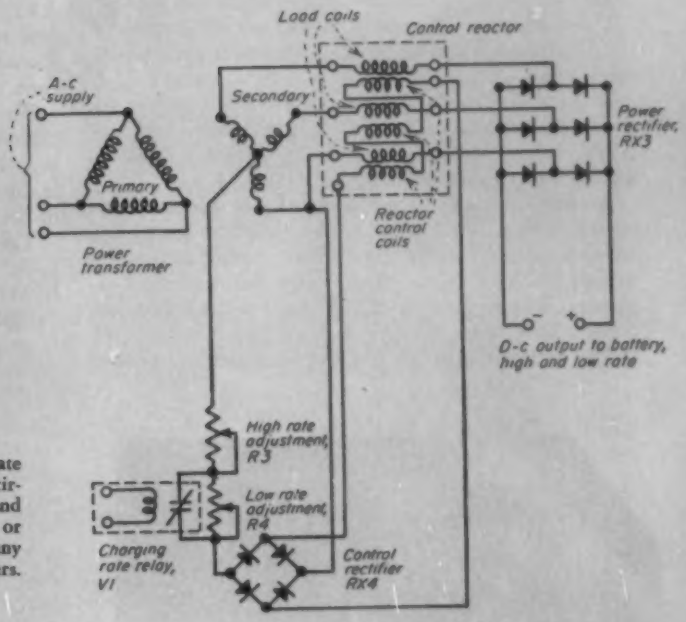


Fig. 9—Basic details of a reactor controlled two-rate battery charger. Unit is similar to motor control circuit in that power and control rectifiers are used and control is accomplished with a magnetic amplifier or control reactor. These features are common to many industrial applications using selenium rectifiers.

15 percent after five years of continuous operation so that for most industrial applications no means of adjusting the input a-c is necessary.

Since selenium rectifier cells consist of two conductors separated by a nonconductor, they have definite electrostatic capacities. Although the impedance of this capacitance will vary somewhat with voltage and frequency, this characteristic is negligible at ordinary commercial power frequencies.

When selenium cells are disconnected from the a-c supply for a considerable time, some degree of rectifying value is lost. It can take as long as 60 cycles to restore them to normal when they are reconnected. This momentary loss of impedance can be neglected in most industrial applications; however, it can be important in control and signal devices where a fast time of response is required.

Selenium rectifiers are essentially high efficiency devices, with a three-phase rectifier at constant voltage and from 50 to 200 percent of rated load having an efficiency of over 80 percent. Also, since they offer primarily resistive impedance, power factor is close to 100 percent.

Mechanical Considerations

Mounting, cooling and protection from environmental conditions are the principal mechanical factors involved in selecting and applying selenium rectifiers. Physically, most selenium rectifiers are similar to that shown in Fig. 2 and are mounted with short metal brackets secured to the assembly bolt. NEMA has established standards to cover the size and shape of these mounting brackets as supplied by rectifier manufacturers. Smaller rectifiers may be square in shape or sealed with pigtails, Fig. 7, while units for special applications can be any shape, Fig. 1.

Since the temperature of a rectifier directly affects its capacity, all units should be mounted to obtain maximum heat transfer. Forced cooling is often used, since blowing air across a rectifier permits operation at higher ratings than when cooling is accomplished by natural convection.

For severe environmental conditions the rectifier can be mounted in a metal can that is filled with oil and sealed. Although weight and size are increased, the oil immersed unit has the advantage of increased thermal capacity.

Applications

Large and medium size selenium rectifiers have been put to such industrial uses as individual machine d-c supply, motor control, dust precipitation, battery charging, welding, and voltage and frequency regulation. The following covers circuits that are typical of these applications.

The two most important factors in the present day increase in the use of selenium rectifiers are the magnetic amplifier and the trend towards the use of d-c machines for adjustable speed drives and load control. Many times these two factors are combined where self-saturating magnetic amplifiers are the basic element in motor control circuits.

Rectifier motor applications can be classified as follows:

1. To deliver d-c power to a motor; usually three phase.
2. To deliver d-c power to motor control circuits; usually single phase.
3. To block a circuit and permit current flow in only one direction; for example, in a two-field reversible motor, the rectifier de-energizes one field or the other depending on the direction of rotation.

A motor control circuit designed for constant load control is shown in Fig. 8. A three-phase bridge rectifier supplies the main motor power, while control field power is supplied by a single phase bridge rectifier through a magnetic amplifier. These rectifier units perform functions 1 and 2 listed above.

The control coil of the magnetic amplifier is connected across the interpole windings of the motor. Therefore, the voltage applied to the control coil is proportional to load current through the motor armature. If the motor load increases above a preset value, the amplifier control coil current also increases. This tends to saturate the amplifier core and reduce the impedance of the main amplifier coils. The a-c input to the rectifier, *RX*1, increases and the motor control field is strengthened, reducing motor speed and load. A decrease in motor load will have the opposite effect, reducing field strength and increasing motor speed. Thus, motor load is maintained constant at a value determined by the setting of variable resistors *R*1 and *R*2.

Main motor power is supplied by the three-phase bridge, *RX*1, because of the smooth output characteristic of this type rectifier as shown by the wave form in Fig. 3 (B). Circuit induction will also tend to smooth out this wave form even more.

The pulsating output of the single-phase bridge, *RX*2, as shown by the wave form in Fig. 3 (A), is satisfactory for supply power to the control field since smooth output is not as important in this application and the induction of the field circuit flattens out the current curve.

The use of three-phase rectification for power and single-phase rectification for control is also demonstrated in a typical selenium rectifier battery charger with reactor (magnetic amplifier) control, Fig. 9. Basically this circuit is similar to Fig. 8, since the two rectifier arrangements perform associated functions.

This circuit is designed for two-rate charging. Initially the control reactor saturation and load coil impedance is controlled by the high rate adjustment, *R*3. The low rate adjustment is shorted-out by the normally closed charging rate relay, *VI*. Just before the battery voltage reaches the excessive gassing point, the relay *VI* opens and the input to rectifier *RX*4 is reduced because of the increased resistance, *R*3 plus *R*4, in the single-phase supply line. This in turn reduces reactor control coil current and the output of the battery charger.

Variations of this basic circuit are typical of many industrial applications where rectified d-c is required for power and control purposes. Where small amounts of d-c control power are required the single-phase rectifier can be used by itself, or where large amounts of d-c are required in constant power or manually controlled circuits, the three-phase rectifier is used.

Another recent application of selenium rectifiers is in industrial dust precipitators, Fig. 1. These units are special in that the rectifiers must operate in the voltage range from 35 to 75 KV with power capacities from 6 to 15 KW. The high voltage rectifier, Fig. 10, is oil immersed to reduce insulation clearances, suppress the corona and to prevent dust and dirt from clogging the unit.

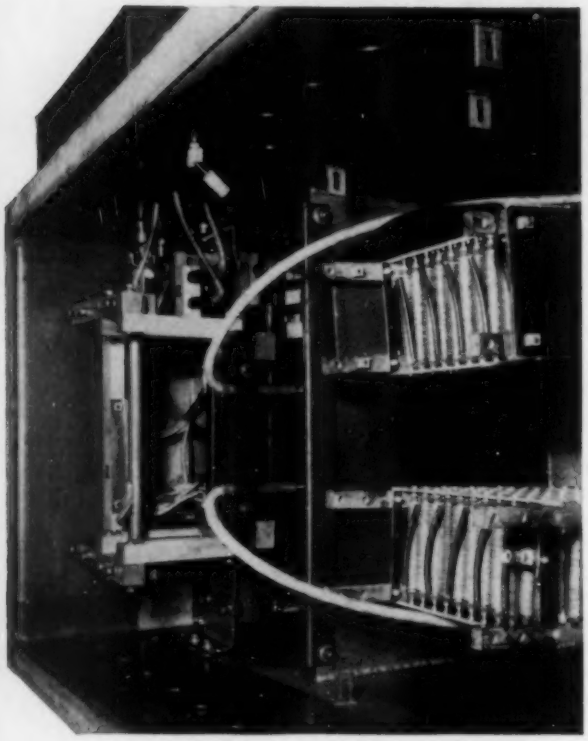


Fig. 10—Dust precipitator rectifier unit with cover removed. Individual rectifier stacks have been designed that will handle a load of 5KW at 70 KV. These are paralleled if precipitator requires higher output. Unit is oil filled after cover is secured and sealed.

Acknowledgments: The author would like to thank the Westinghouse Electric Corp. for assisting in the preparation of this article.

SELECTED REFERENCES

1. Standards for Metallic Rectifiers, National Electrical Manufacturers Association, Publication No. MR1-1953, April 1953.
2. Metallic Rectifier Design and Application, Julian Lobenstein, Radio Receptor Co., Inc.

TECHNICAL NEWS

NEW X-RAY INSPECTION TOOL

ELECTRON GUN at the starting end of Stanford University's new six million volt linear accelerator nearing completion on the Palo Alto campus. Next year, General Electric Company will start commercial production of such machines for X-ray testing.

STANFORD UNIVERSITY'S LINEAR ACCELERATOR—a billion volt atom smasher (*Product Engineering*, Feb. 1953, p. 201)—is going commercial. The X-Ray Department of General Electric Company has signed a 10-year agreement with the college to turn out "toned-down" junior sizes for inspection of industrial products and medical therapy.

Behind the move are two factors: GE's desire to provide a complete line of commercial equipment, ranging in voltages from 30,000 to 70,000,000 and the potentialities of the linear devices for reducing the cost of high voltage X-ray apparatus.

Presently the company is filling orders for high voltage gear with betatron-synchrotron types of equipment. But such apparatus is expensive and it's not easy to build in a variety of sizes; each rating requires a complete design of its own. Linear accelerators, on the other hand, have a basic design. Higher or lower ratings can be obtained by adding on or leaving off acceleration sections, and making relatively minor modifications in the machines.

In the Stanford-designed accelerator, a gun shoots electrons into copper piping that serves as a wave guide. The negative particles ride down the length of the guide on electromagnetic waves. At specified intervals, oscillators supply an energy kick to the particles, adding energy until the rating is reached. When the particle reaches the end of the tube, its speed is very close to the velocity of light. And, each section of the long device has served as a small linear accelerator.

At the far end of the machine, electrons hit a metal target forming high energy X-ray radiation, or are removed to supply high energy particles.

The company predicts that it will be several years before it is ready to market such devices. GE engineers will spend the next twelve months on the Palo Alto campus studying design and construction of linear accelerators.

Main interest will be directed at the new six million volt machine Stanford's Microwave laboratory is building for the college's school of science. It's expected that this machine will be the model for GE's commercial equipment. Several of the microwave specialists working on this machine will serve as consultants to the company when manufacturing starts.

Now GE thinks that the commercial machines will be made in the range of 2,000,000 to 70,000,000 volt sizes.

U. S. Department of Commerce Commercial Standards CS 192-53	
1. Thickness:	Maintained within plus or minus 10 percent.
2. Width:	Held to a tolerance of plus ½ to zero in. of specified width.
3. Length:	Length of material, excluding that which has been subjected to treatment such as embossing or printing, shall be continuous in any one roll.
4. Shrinkage at High Temperature:	Average dimensional change shall not be greater than seven percent in any direction when tested at a temperature of 212 F for 30 minutes.
5. Contamination:	Material shall be commercially free from pin holes, particles of foreign matter, undispersed raw materials and visible holes.
6. Appearance:	Material shall be commercially free from visual defects like "cold-checks", "crows feet", "pine trees", "streaks" and "blisters"; it will have smooth edges, free from cuts and nicks.
7. Crocking (Color rub-off):	No perceptible color transference from the Vinyl film to any other material.
8. Tensile Properties:	Minimum tensile strength—2,100 to 2,300 psi, depending on which approved method of testing is used; minimum elongation—150 percent.
9. Tear Resistance:	Minimum average tensile tear strength of the material, either plain or after embossing—200 lbs per in. in any direction.
10. Elmendorf Tear Resistance:	Minimum average Elmendorf* tear strength (either plain or after embossing, if embossed) in any direction—180 grams per sheet for film 3 mils or less in thickness, 60 gram per mil for film greater than 3 mils thick.
11. Plasticizer Volability:	Average weight loss, based on initial film weight, —not more than 10 percent for film 3 mils or less in thickness, 9 percent for 4 mils, 7.5 percent for 6 mils, 5 percent for 8 mils when tested in accordance with the approved method.
12. Water Extraction:	Average weight loss less than one percent when tested in accordance with the approved method.
13. Low Temperature Impact:	Not more than two samples out of ten fail when tested at OF.
14. Flammability:	Rate of burning does not exceed 1.2 in. per sec. as judged by the average of five determinations lengthwise and five transverse to the direction of processing when conducted with SPI Flammability Tester. (This meets Public Law 88 for wearing apparel.)

*Elmendorf tear strength determined in accordance with ASTM D689, "Method of Test for Internal Tearing Resistance of Paper", except that readings obtained where the tear deviates more than 10 mm (⅜ in.) from the line of the initial slit are not rejected when obtained with embossed films.

VINYL FILM STANDARDS

SIGNS THAT THE VINYL FILM INDUSTRY is reaching maturity were evidenced last month when Society of the Plastics Industry, Inc. announced the adoption of an industry-wide standard (see above) covering the properties of vinyl sheeting. Purpose of the specifications: to insure a minimum quality for users who fabricate various products from such films. The new standards, incorporated in U. S. Department of Commerce Commercial Standards CS 192-53, form the basis of an extensive program aimed at stabilizing production quality. In addition, SPI announced a "seal of quality" to identify products made from materials produced under the new specifications.

AF SHELVES "ONE CONTRACTOR" PROGRAM

WASHINGTON—U. S. Air Force has abandoned attempts to have a single prime contractor do all the subcontracting for aircraft "Weapons Systems"—the complex of electronic gear, motors, compressors, and cables that point and fire weapons.

Early last summer, USAF procurement chiefs indicated that they would shift to a single system method of contracting, where possible, meaning one contractor would be responsible for everything that went into the airplane except items that are aerodynamic or ballistic in nature.

The switch was based on the argument that the electronics and guidance systems of present aircraft are so complex that everything else in the plane should be geared to them. For example, the electronics equipment in several interceptors now not only takes over flight of the aircraft but searches out the enemy, flies an interception course and fires the guns at the proper moments. And since electronics is the key to the whole system, electronics people felt they should have the final say in what types of hydraulic controls, auto pilots, engine and navigation instruments and ordnance go into the plane.

However only one contract was let under the program—Convair won an award for the development of a bombing system to go into the strategic Air Force's new intercontinental XB-58. Meanwhile, opposition to such procurement had arisen from a number of component manufacturers. They protested that the single system method of contracting was likely to create monopolies out of defense business and do away with government guarantees of competitive bidding. An additional defect was that procurement under such a plan would be likely to escape from government supervision.

As a compromise, the USAF will contract with a single prime contractor to develop a complete weapons system, but component manufacturers will still enter into contracts with the Air Force as "primes".

The systems contractor will establish and provide the performance specifications for the components with the approval of the Air Research and Devel-

opment Command. Then the Air Force will award contracts, buy the components, and supply them to the systems contractor as "Government Furnished Equipment".

Until recently, the Air Research and Development Command and the Air Material Command were responsible for setting specifications and coordinating the procurement of components for specific aircraft. Under the new regulations, they still have that responsibility, but the design of the control systems of the aircraft—the part that seeks out, finds the enemy, and then fires the guns or drops the bombs—will be largely the product of one contractor's standards and specifications. That way, the Air Force hopes to insure better results in its weapons systems.

MAGNETIC CLUTCH PATENTS

EATON MANUFACTURING COMPANY, holder of patent rights covering an advanced principle of electro-magnetic clutching, braking and power transmission using a magnetizable powdered metal and dry lubricant mixture, is rounding out its patent coverage in this field. Their latest acquisition: foreign rights to the Jacob Rabinow patents, which also have a basic application in this field. The Rabinow (of the National Bureau of Standards) patents cover certain aspects of using powdered iron as a magnetic medium.

The electro-magnetic principle, as covered by Eaton patents, applies to the use of powdered magnetizable metal in a mixture with dry powdered additives for a clutch, brake, transmission, or similar assembly.

A magnetic coil and complete magnetic circuit magnetizes the mixture of fine metal particles and dry additives and lubricants, drawing them together in a strong transmitting bond when magnetizing control current is applied. The mix is literally "frozen" or "unfrozen" in direct proportion to the amount of current applied.

Big uses of such devices appear in automotive and aircraft manufacturing and in paper, textile, machine tool, home appliance, and other fields. The clutches can be built with a broad range of capacities.

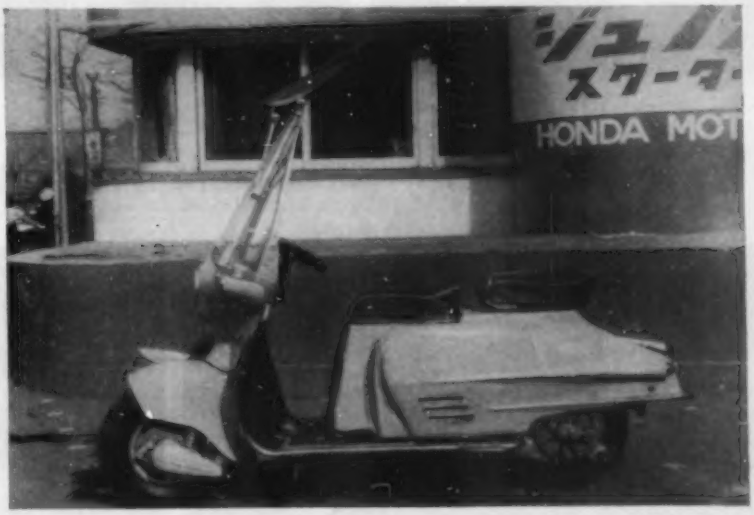
NEWS BRIEFS

• Chicago's International Amphitheatre will be the scene of the second Basic Materials Exposition on May 18-20. Show producers Clapp and Poliak predict that the display will more than double last year's premiere effort. Technical men will hold a three day product development conference in conjunction with the exhibit.

• John Findley Peters, who never went to high school or college because of financial reasons, received the 1953 Edison Medal at last month's winter meeting of the AIEE. The Westinghouse Electric Corporation engineer won the fifty-three year old award for "his contributions to the fundamentals of transformer design, his invention of the Klydonograph (a device for recording power transmission system surges), his contributions to military computers and his sympathetic understanding in the training of young engineers". Other distinguished previous winners: Alexander Graham Bell, Vannevar Bush, George Westinghouse, and Lee de Forest.

• Number of telephones in the world reached 84,000,000 early in 1953. Statistical leader was the United States with 50,000,000 (as of November 1953); United Kingdom trailed in second place with 6,000,000. Areas still without commercial telephone service include Greenland where four-fifths of the area is ice-capped and Pitcairn Island in the Pacific, home of the "Bounty" mutineers' descendants.

• Frank S. Wartman, veteran Bureau of Mines Metallurgist, won the Department of Interior's highest honor, the Distinguished Service Award, for his part in developing a practical production process for titanium. Having started his study of this light metal in 1938, it was Wartman (above) who selected the magnesium reduction of titanium tetrachloride as the method most suitable for the quick development of tonnage production.

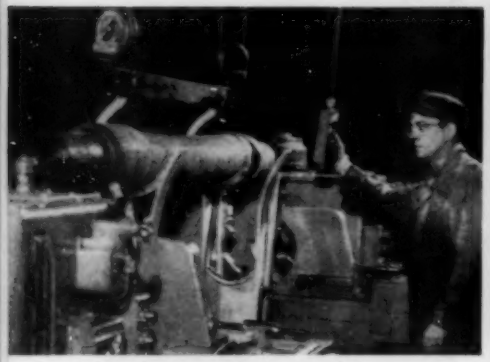


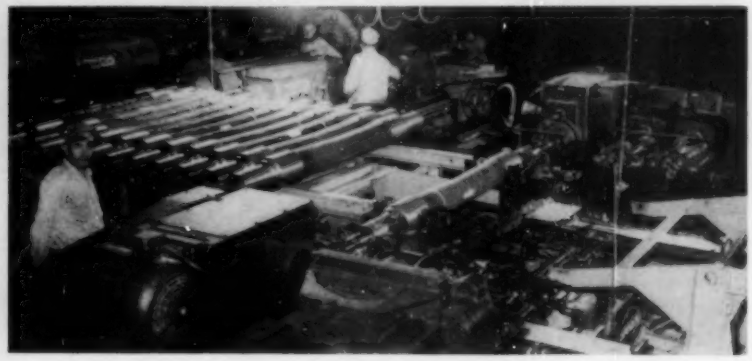
• Japanese scooters are getting plastic bodies. The "Juno" made by Honda Motor Company of Tokyo in its polyester shell weighs only 286 lbs. It has a 6.5 hp three speed engine. Equipment includes a self-starter, but the price is high at 200,000 yen ($555).

New Production Facilities for . . .

. . . Axles

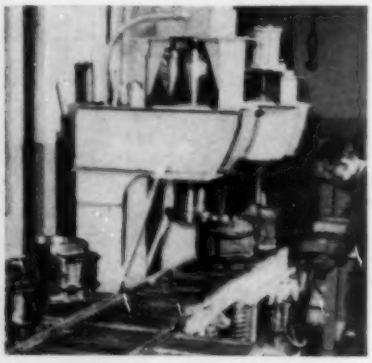
At start of production line (below, left), workman presses push button to automatically load forging into double end centering machine. After piece is rough turned and wheel seats are finished, the axles roll down into automatic machine (below) where they are drilled, countersunk and tapped at both ends.





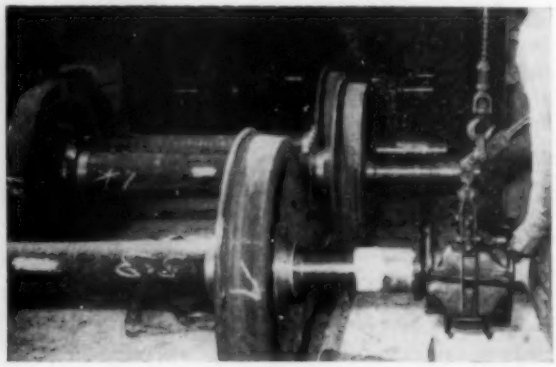
. . . Journals

Start of journal box fabrication takes place at this cleaning tank where grease and dirt are removed from housings (below, left). And roller bearings are assembled (below, center) in a three step operation. First (below, right) operator presses both tapered cones into the journal box simultaneously.

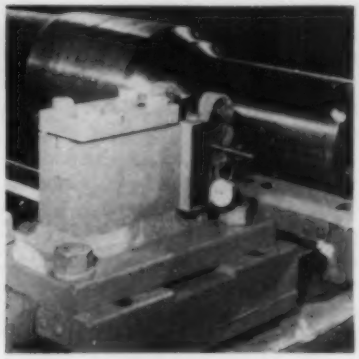


. . . Assemblies

Wheels are mounted on finished axles with the aid of special journal protectors (below, left). Then wheel seats are pressed on. Electric hoists with special slings are used to mount journal box on the starting sleeve (below, right).



Journals and dust guards are finish turned on a dual carriage lathe (below, left) which is equipped with an air gage tracer. Then burnished and cold worked (below,center). Finished axles roll onto racks (below, right) where railroad inspectors check them for dimensional accuracy and appearance. Line maintains high precision at high production rate.



Then a special press (below, left) measures the lateral motion and side play in the assembled journal boxes. A third hydraulic press then forces the seal ring into the journal box (below, center). Final assembly and inspection (below, right) takes place close by line where wheels and finished axles pass. Any manufacturer's roller bearings can be incorporated into the journals.

. . . Means More Roller Freight

INTRODUCED SEVERAL YEARS AGO for the first time, roller bearing freight car journals are finally coming into their own. American Car and Foundry Company predicts that, in the near future, all freight cars will travel on trucks equipped with such bearings.

To back up this estimate ACF has just opened a new mass production line at their Huntington (West Virginia) plant, the first high-capacity installation devoted exclusively to the preparation of railroad freight car axles for roller bearings. And at present, the company is processing a king-sized order for 600 roller-bearing-equipped, covered, hopper cars bought by the Atlantic Coast Line Railroad. Industry observers call it the forerunner of a big switch from conventional journal trucks.

ACF's new facility (see photos above) represents the culmination of a five year study by the company's engineers, a study aimed at building high volume production while maintaining a high degree of precision—and at the same time redesigning shop equipment so processing becomes as automatic as possible.

In the resulting production setup, axle forgings successively move to centering, turning, drilling, tapping, grinding and burnishing operations, carried from one machine to the next by tram-rail hoists. After the operator of the first machine starts the axle on its way, all other processes are automatic. In another area of the plant Timken Roller Bearing journal boxes are assembled, then pressed onto wheel-axle assemblies.

JOINT COMPUTER CONFERENCE

COMPUTERS have developed into big business, commanding an increasing amount of serious attention from enginers and scientists. Visitors to the recent Third Eastern Joint Computer Conference and Exhibition, held in Washington, came away with a vivid impression of activity after viewing an extensive display—three times bigger than last year's—and the heavy registration, over 1,150 people paid for the privilege of listening to the technical presentations.

Listeners heard an old story—performance reliability—brought up to date with a new slant: component failure is not always the fault of the component. L. D. Whitelock, U. S. Navy, Bureau of Ships, set the stage for such thinking with a paper "Methods Used to Improve Reliability in Military Electronic Equipment".

In analyzing equipment failures, the Navy specialist assigned responsibility as follows:

- Engineering was responsible for 40 percent of all failures, the result of errors, omissions, negligence, and bad judgment on behalf of design engineers.
- Faulty installation, operation and maintenance caused 20 percent of failures as gear was handled 1) in a manner not in accord with prescribed procedures, 2) without adequate procedures or 3) with incorrect procedures.
- Manufacturing mistakes accounted for 10 percent of all failures. Such errors were about evenly divided between faulty workmanship and failure to build and test equipment according to proper specifications.
- Faulty components were at the root of the remainder, only 30 percent of failures.

Several other papers backed up Whitelock's assumptions by describing specific computer operations and "breaking-in" experiences. Component manufacturers themselves appeared on the program, urging computer builders to evaluate circuits and applications before condemning a component as inferior. Many case histories of component failure were traced to illustrate how faulty design hides behind such failure. Typical example: a one-half watt resistor in a computer failed by exploding; when several resistors had failed in the same manner the line was condemned as being unsatisfactory. But investigation showed that the component was not protected from overloads and the particular circuit was subject to faults that sent about 200 watts through the resistor. Of course the component was unable to carry an overload 400 times its rating.

Whitelock offered some sound advice for computer designers based on Navy experiences. His recommendations:

- Use JAN or MIL or equivalent tubes, resistors, condensers and other components with the proper de-rating factors where listed in MIL specifications.
- Rely on conservative mechanical and electrical design.
- Air condition gear, particularly when transistors are used (this includes both heating and cooling).
- Make the equipment accessible for maintenance.
- Use simplified and standardized circuits.

In the exhibit halls, the computer scientists concentrated on a search for new ideas. Forty-four suppliers were ready to help. Their displays covered components — vacuum tubes, transistors, potentiometers, servos, resistors, diodes, and precision mechanical parts —recording instruments, automatic plotters, memories, and computer services. In displaymen's opinion, the Computer Conference, sponsored jointly by American Institute of Electrical Engineers, Institue of Radio Engineers and the Association for Computing Machinery, has developed into a major technical meeting.

MORE TITANIUM

NEW GOVERNMENT MONEY—roughly $75 million—is being lined up to boost the nation's capacity to produce primary titanium up to almost 35,000 tons annually by 1957—more than double the present 13,200 ton capacity now scheduled to be in place at that time.

The General Services Administration expects to sign contracts advancing these funds for new plant and equipment within 90 days. Companies most likely to land them: du Pont Co., Titanium Metals Corp. (jointly-owned subsidiary of Allegheny Ludlum Steel Co. and National Lead Co.), Monsanto Chemical Co.

Du Pont and TMC already have GSA titanium contracts. But in luring only du Pont (projected output in 1956, excluding the new contract: 3,600 tons annually), TMC (3,600 tons), and Crane Co. (6,000 tons) into the titanium business, GSA has fallen far short of the Office of Defense Mobilization's 25,000 ton expansion goal.

And even current production is lagging behind schedule. Total 1953 commercial output was only about 2,400 tons—by du Pont and TMC. There was also some meager tonnage from U. S. Bureau of Mines Laboratories and several privately owned pilot plants. This year's production is supposed to reach 5,500 tons.

The bottleneck has been one of technology.

Officials at both GSA and ODM claim they've been unable to find new producers far enough developed to justify heavy advances of government money. And they've been reluctant to put all their eggs in one basket—the uneconomic Kroll process.

The plan to sponsor an embryo titanium industry consisting of about 10 producers using as many as five different processes is being upset. The Air Force and aircraft manufacturers—working through a Senate subcommittee on minerals headed by Senator George Malone (R., Nev.)—have pressured for more metal more quickly.

According to testimony brought out during the Malone subcommittee's hearings, requirements have gone up substantially. In fact, many contractors are holding back on designs requiring titanium because of the metal's shortage. The Pentagon is now making a new survey, and expects to produce

the most current estimate in March.

The subcommittee heard revolutionary reports of plans for titanium. Samples:

• Col. Benjamin Mesick, Commander of Army Ordnance's Watertown, Mass. arsenal, disclosed that titanium could reduce the weight of a 28 ton tank to 20 tons, the weight of an 81 mm mortar from 50 lbs. to 22 lbs. Other potential Army uses: armor, grenade launchers, bayonets, entrenchment tools, helmets, and heavy artillery. Assuming changes in specifications, the colonel said potential army use of titanium could total one million tons yearly.

• Air Force Brig. Gen. Kern Metzger, an air materiel command official, and a prime mover in setting up the hearings, implied that the military services could use as much as 100,000 tons of titanium a year almost immediately.

• Roy Hurley, Board Chairman, Curtiss-Wright Corp., estimated that if titanium were freely available his company alone could use 36,000 tons annually by 1956 in the commercial and military aircraft engines it expects to manufacture.

• William O'Donnell, Chief Development Engineer, Republic Aviation Corp., emphasized that titanium is essential for the high-speed fighter aircraft and guided missiles now approaching production. In the speed range of 1,250 mph to 2,500 mph, there will be serious performance disadvantages if heavier stainless steel rather than titanium is used, he said. He estimated that 99 percent of the structural weight of the high speed fighters should be titanium.

• Leo H. Harvey, president, Harvey Machine Co., reported that by 1955 aircraft engine manufacturers could use 50,000 tons of titanium annually and an additional 50,000 tons each successive year, until minimum requirement of 250,000 tons annually is reached. He said airframe makers have reported similar requirements eventually, making a total 500,000 tons.

But the enthusiasm for titanium is not unanimous. Many officials in civilian and military government agencies are skeptical that the manufacturers can really use as much titanium output as they would like the government to stimulate.

They're also pessimistic about chances for cost reduction at both the primary and fabricating levels in the near future. A more economical reduction process than the Kroll method would reduce the price of sponge, but an equally important task, they point out, is to cut fabricating costs. Titanium mill products like sheet, bar, and rod now cost an average $15 a lb.

Big trick would be to develop an economic melting process to form ingots. It takes about 2 lbs of titanium sponge to make 1 lb. of mill product. And though you make as much scrap as finished production, only about 10 percent of the scrap is used.

One ODM official claims the military services would have to tie up $1 billion for purchases of sponge, over $5 billion at the fabrication stage, to cover such large production. With administration talk of defense budget cuts of around $5 billion, it seems unlikely that the military services could actually buy all the titanium products that some of its brass say they need.

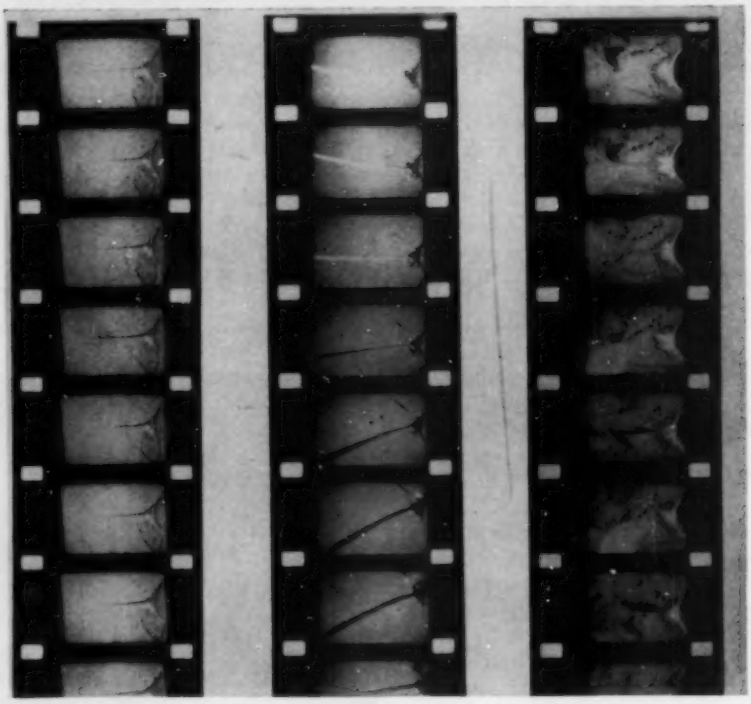
Officials at GSA are worried about what would happen if congressional appropriations to the military are inadequate to cover the titanium production for which they will grant market guarantees.

CADILLAC SERIES 60 SEDAN and

BUICK ROADMASTER for 1954 indicate General Motors' styling trend for the next few years. Both lines boast completely new body shells this year. Most striking element is the vertical window pillar enfolding the new panoramic windshield. Other changes: emphasis on straight horizontal lines; longer, lower bodies (some Buicks increased over five inches); air intakes moved to narrow slit under windshield and equipped with moisture trap that permits all-weather ventilation; more horsepower—some Cadillac models upped to 230 hp, Roadmaster V-8 rating increased to 200 hp.

THE NEWS IN PICTURES

ROCKET VEHICLE with camera head is used by Lockheed Aircraft Corporation engineers to study effects of different wing shapes. During flight, camera photographs research wing model producing . . .

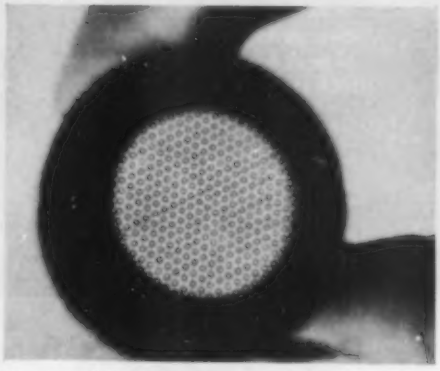


. . . FILM STRIPS like these that reveal behaviour of wings during flight. Strip at left shows a thin straight wing satisfactory for supersonic flight; in center, one of a series of straight wings made flexible to determine boundary of failure at high speeds; and at right, swept wing derived by sweeping back the straight model of the center strip and increasing its stiffness—this one failed after reacting violently.

NEW JET HELICOPTER developed for the Defense Department hovers over the ground during recent tests. Built by Hiller Helicopters, the two seater craft is powered by ram jet engines mounted at the tip of the 23 foot rotor blades. Performance features were not announced; but proposed functions of the machine include training, reconnaissance, and wire laying. A small number of these ships are being produced for evaluation by the Navy, Marines and Army. There are no plans for commercial production.

Printing Color Dots

Color Dot Inspection



Close-up of Dot Pattern

COLOR TELEVISION TUBES and how to make them have hindered adoption of compatible color TV systems. Last month RCA Victor announced that they were making 15 in. tricolor tubes commercially, having solved the problem of putting the colors onto the picture tube economically. The answer: a triple silk screening process to apply red, green and blue dots. After printing, an inspector checks the pattern for characteristic triangular registry. There are 200,000 groups made up of 600,000 dots.

KAISER DARRIN 161, plastic sports car first scheduled for production in January 1953, is making its appearance this month at Kaiser-Willys dealers throughout the country. Powered by a Willys six-cylinder 90 hp engine, the 161 is only three feet high from ground to cowl, 210 in. long, and weighs 2,175 lbs. List price, exclusive of state and local taxes, $3,668.

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A smaller, better power package to meet new NEMA standards

with NEW MODERN STYLING

plus

Improved ventilation
New conduit-box arrangement
New bearing construction
More compact design and better protection
More versatile mounting

Here you have complete use of modern motor materials, design techniques and new manufacturing methods. You also get more power in a smaller package — and clean, streamlined motor styling to add modern appearance to the equipment these new motors drive.

This new styling is completely functional. Ventilating grilles, for example, blend into the general motor design — yet they provide better protection, greater safety, admit more cooling air.

Completely enclosed housing provides protection for the new L.A. line in any mounting position — floor, sidewall, or ceiling.

Standardize now on the new L.A. line for both your product and your plant — and get the most modern motor construction available. See your nearby Louis Allis Sales Engineer today for the complete story.

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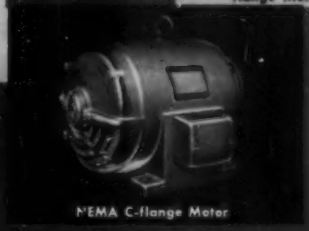


NEMA C-flange Motor

We specialize in SPECIAL MOTORS — *and* PROMPT DELIVERY, TOO

There's a Louis Allis special motor for your toughest application. Whatever electrical or mechanical modifications you need, there's one right from Louis Allis.

Bearing Load Analysis Using Polar Diagrams

RICHARD J. DERKS*

Assistant Professor of Mechanical Engineering
University of Notre Dame

WHEN APPLYING belt and chain drives to power transmitting devices, excessive side loads frequently are a source of trouble. Improper selection of sheaves and arrangement of connections result in poor bearing life and early shaft breakage. A thorough analysis of bearing loads and shaft stresses is necessary if these are to be avoided.

The use of polar diagrams provides a unique method of determining the maximum permissible side loading and the minimum size sheaves on an overhung shaft where gear loading is present. This type of analysis gives a graphical representation of limiting side loads with relation to their corresponding directions of pull. In its essence it becomes a permanent data sheet for an individually designed unit to which future reference is readily available.

Referring to Fig. 1, it is required to determine the directional side load limitations at the specified location of output sheave. The maximum torque transmitted by the pinion is 1,600 lb-in. The tangential and separating forces at the point of tooth contact are 1,970 lb, and 718 lb respectively. These combine vectorially as shown to give a resultant force R of 2,100 lb which can be replaced by a parallel force R' of equal magnitude at the shaft centerline and a moment of 1,970 $\times$ 4 = 7,880 lb-in. in a plane normal to the shaft centerline. As shown in Fig. 2, the resultant loads at bearings A and B are 1,575 lb and 525 lb, respectively. Next, each bearing load condition must be treated separately.

The key to the solution is to replace R' with fictitious forces in the plane of the output sheave of such magnitudes that the bearing loads are unchanged. Fig. 3(A) and 3(B) illustrate the procedure and the necessary forces with their directions of application. These fictitious forces, if plotted to some convenient scale on polar coordinate paper with the leading edge of the vector at the origin will represent the bearing loads resulting from gear action.

If the side load is applied in the same direction as fictitious force R'_A, it will be limited by the allowable bearing capacity of Brg A at the given shaft speed. Assuming that the maximum permissible radial load on this bearing is 2,100 lb, the resultant radial force, R'_A, acting in the plane of the output sheave must not exceed 2,400 lb, since from Fig. 3(A), (1575 + 525)4 = (1800 + 600)3.5. Of this 2,400 lb, the fictitious force of 1,800

* Formerly, Design Engineer, Twin Disc Clutch Company.

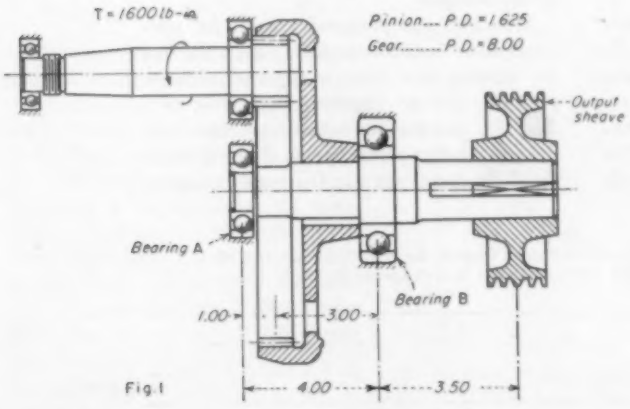
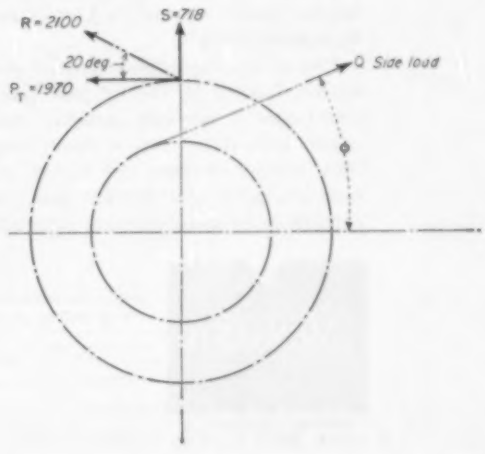


Fig. 1



New materials "spark" new ideas

...new HI-TEST 88 LUSTREX Styrene Plastic

5 times tougher than general purpose styrene

Housings for office equipment, room air-conditioning units, and many types of household appliances are today not only possible but practical in a new, stronger and tougher styrene plastic: Monsanto's Lustrex Hi-Test 88 styrene plastic.

Five times tougher than general purpose styrene, Lustrex Hi-Test 88 can "take" the punishment a portable dictating machine usually gets. It has two to three times the "flex" strength of other "high-impact" styrene materials, good light stability, and superior appearance including excellent surface finish.

And of course its "one-shot" moldability means that handles and other parts can be molded right in, eliminating assembly costs. Corners and sharp edges become modern streamlined curves according to the wishes of the designer.

Monsanto has prepared a study of new-application possibilities for Lustrex Hi-Test 88, showing how different types of products can be improved with this new material for better appearance and better performance. If you'd like a copy, just use the handy coupon.

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Please send me your new booklet of design ideas in Lustrex Hi-Test 88 styrene.

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lb must be considered a definite component. The actual applied load would then be limited to 600 lb, in the direction of R'_A. If applied in the opposite direction, the limiting side load becomes 4,200 lb since it acts to nullify rather than to complement the fictitious force in producing bearing load. It is now apparent that a circle of 2,400 lb equivalent radius, R'_{AL}, would result in a polar diagram of permissible side loading for design life of Brg *A*. The validity of this operation is understood by noting that the equivalent radius is always the resultant of fictitious force R'_A and the rotating vector which represents applied side load.

This same procedure is repeated for Brg *B* which is assumed to have a design life compatible with 3,750 lb max. rated load. When super-imposed on one another, these diagrams give a confined realm of loading (*k-l-m-n*) shown in Fig. 4. Using the chosen scale, it is now possible to conveniently measure load limitations in any direction. When dividing the torque transmitted at the sheave (7,880 lb-in.) by any maximum indicated side load, the corresponding minimum sheave diameter is obtained.

Now that the side load limitations, as based on desired bearing life, have been established, the imposed shaft stresses are analyzed. Consider the stress to be critical under Brg *B*, and, for safe loading limit, the maximum equivalent bending moment to be 7,200 in.-lb. The equation for combined bending and torsion is

$$M_e = \tfrac{1}{2} M + \tfrac{1}{2} \sqrt{M^2 + T^2}$$

By substitution of known quantities,

$$7{,}200 = \tfrac{1}{2} M + \tfrac{1}{2} \sqrt{M^2 + 7{,}880^2}$$

The maximum allowable bending moment is then 5,000 in.-lb. At the specified distance of overhang, the side load, *Q*, caused by chain or belt pull is therefore limited by shaft strength to 1,430 lb in any direction. This limitation is illustrated on the polar diagram by a circle with center at the origin and radius equivalent to 1,430 pounds. It is evident from this composite diagram that Brg *B* is no longer a limiting factor since it completely encloses the now smaller region of safe loading.

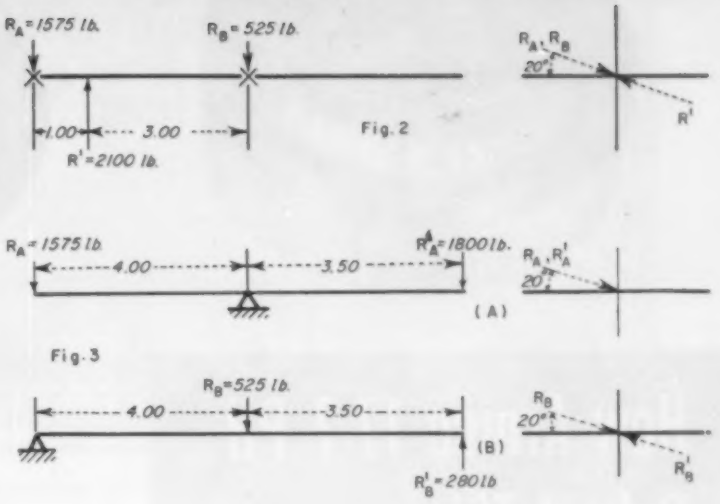

Fig. 2

Fig. 3

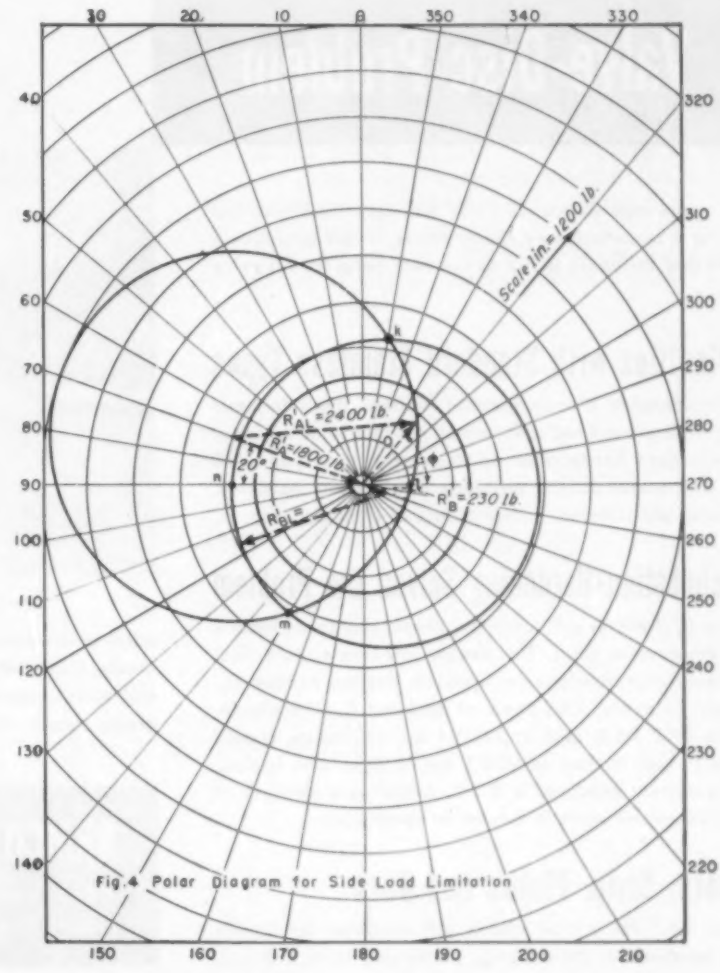

Fig. 4 Polar Diagram for Side Load Limitation

How Armco 17-7 PH Solved This Valve-Disc Problem

ARMCO

Four years ago Armco 17-7 PH Stainless Steel was first tried in a manufacturer's check valves. It met all requirements and continues today as the best metal for his valve discs.

Difficulties with Standard Stainless Types

Non-hardenable chromium-nickel stainless steels formerly used often proved too soft—sometimes had to be nitrided. The standard hardenable stainless steels like Types 410 and 420 presented the problems of excessive hardness, cracking and distortion either before or after grinding.

Precipitation-Hardening Solved the Problem

Armco 17-7 PH, in soft condition, blanks and forms readily into these valve discs. The double low-temperature heat treatment then develops the hardness desired without distortion. To attain a hardness of Rockwell C-41 minimum, Armco 17-7 PH is held at 1400 F for 1½ hours, cooled to 60 F, then heated to 950 F for ½ hour and cooled. This treatment produces a 0.2% offset yield strength of 165,000 psi minimum in tension or compression.

Sheets, Strip, Plates and Bars

Armco 17-7 PH is produced in soft condition for double heat treatment in sheets, strip, plates and bars. It is supplied cold-worked for single heat treatment at 900 F in sheets, strip and wire. For further information on this precipitation-hardening stainless steel and its companion grade, Armco 17-4 PH, write for our latest bulletin.

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4583 Curtis Street, Middletown, Ohio
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Graphical Determination of Stresses Defining Unstable Conditions

MARSHALL HOLT and C. W. deCEAULT
Aluminum Company of America

Many problems involving stability use equations similar to the following:

$$f = KE(G) \quad (1)$$

where

f = the stress defining unstable condition.
K = a constant
E = elastic modulus for elastic action. For inelastic action the subscript t is added.
G = function derived from theoretical considerations of the geometry involved.

By a transformation of Eq (1):

$$\frac{f}{E} = K(G) \quad (2)$$

The right hand side of this equation is a function of geometry alone; the left hand side is a function of the properties of the material. Thus, by selecting a series of arbitrary values for the right hand side and having a graph of f vs f/E, the critical stress f or the stress defining an unstable condition can be found.

If the elastic modulus is used for elastic stresses and the tangent modulus is used for the plastic stresses, a graphical construction of f vs f/E can be made directly from a cartesian plot of the stress-strain diagram for the material used.

Up to the proportional limit, p, the derived curve of f vs f/E is identical with the stress-strain curve. At an arbitrary point, above the proportional limit, q, the value of f_q/E_t is desired and can be obtained by similarity of triangles:

$$\frac{a}{b} = \frac{f_q}{x}$$

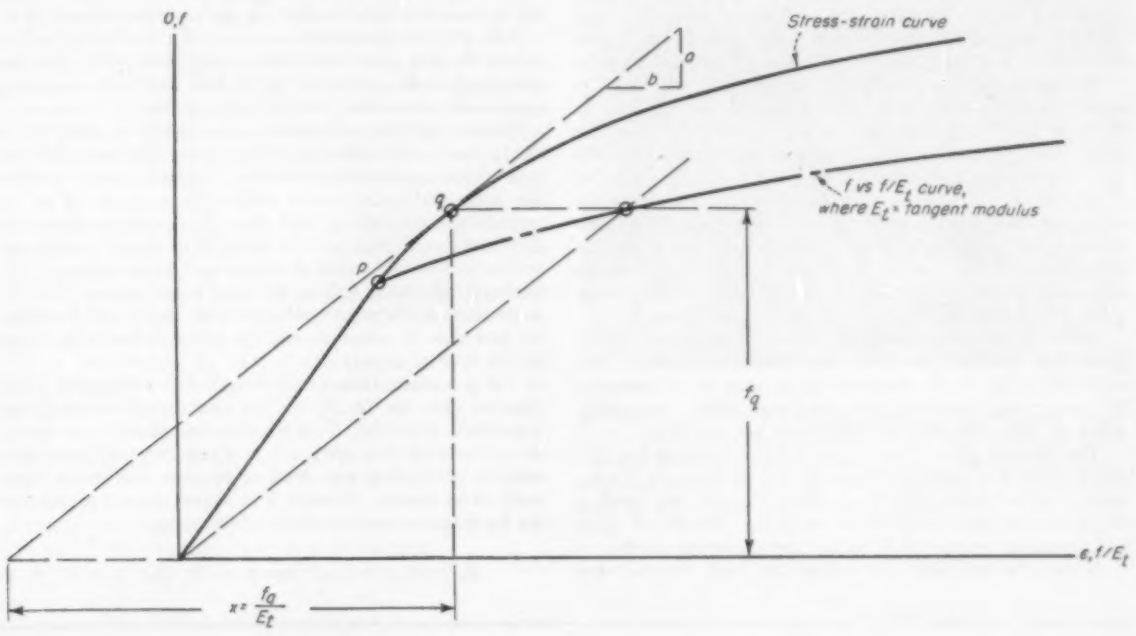
But by definition,

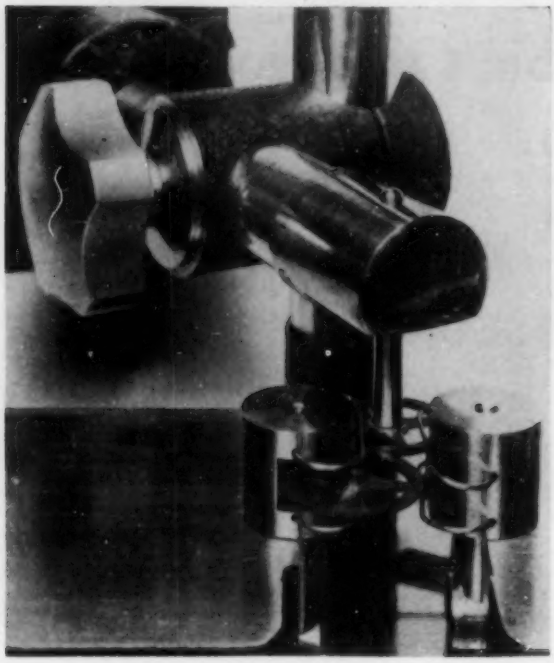
$$\frac{a}{b} = E_t, \text{ thus } x = \frac{f_q}{E_t}$$

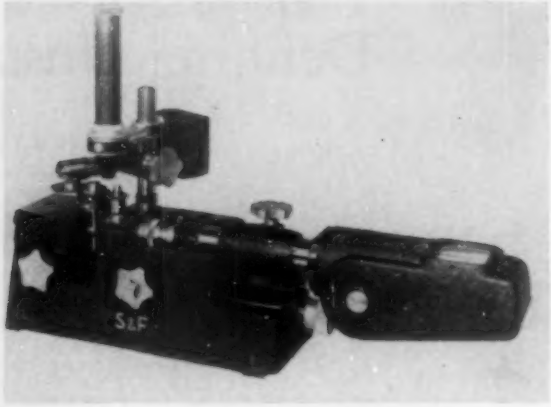
Transferring the slope at q so that it passes through the origin and intersecting this slope with a horizontal line drawn from q, a series of points on the f vs f/E_t curve can be determined. The units on the vertical and horizontal scales of the derived f vs f/E_t curve are identical to those of the original stress-strain curve. The advantages of this method of determining the tangent modulus and stress relation from a given stress-strain curve are two-fold:

(a) Saves calculating time;

(b) Reduces chances for error in calculating, recording, and replotting of data as required by usual methods.







ABOVE. Here the two-flank gear tester is set-up for the inspection of a spur gear. The tester was designed for the inspection of small gears, many of which are made of relatively low-strength materials. A recorder and magnifier may be attached.

THE SET-UP AS SHOWN, LEFT is for the testing of very small gears with needle bearings for a 0.012 in. dia shaft. Gears with their pinions are held in small V-ways and clamped by spring type wires. An overload clutch between the knob and spindle prevents excessive clamping pressure and damage to gears.

Instrument Inspects All Types of Fine Pitch Gears

For the inspection of all types of fine pitch gears, including those of the smallest dimension, a new two-flank universal gear tester can be used for the inspection of spur, bevel and helical gears; worms and worm gears; flat and round racks; pinionshafts; finished and semi-finished gear assemblies; and small gears and pinions used in instruments.

Operating on the principle of rotating the test gear in contact with a master gear, both flanks of the test gear in the new tester are in contact with the master, so that the gears mesh without backlash. The basic instrument provides for visual indication, on a dial with a sensitivity of 1/10,000, of all the errors affecting the actual performance of a gear under operating conditions. These errors are indicated as total composite error, which is made up of runout (including lateral runout or wobble) and tooth-to-tooth composite error, which is the combined effect of circular pitch error, tooth-thickness variation and profile error.

Addition of a mechanical recording instrument gives a permanent graphic recording of errors, and simplifies the analysis of the total composite error into its components of runout and tooth-to-tooth composite error. Magnifications of 100, 200, 250 or 400 times are available.

The smallest gear center distances can be obtained in this tester without additional clamping fixtures or angle blocks. Simple arbors with cylindrical shafts are used for holding the gears; no tapered shafts are required. Height of gears is adjusted by means of V-blocks and clamping knobs.

It can be supplied for either hand or motor-driven rotation of the gears. For high-production testing, a semi-automatic model can be furnished. In this model, the only manual operation is the changing of the test gears. The test operation is then carried out on a predetermined cycle.

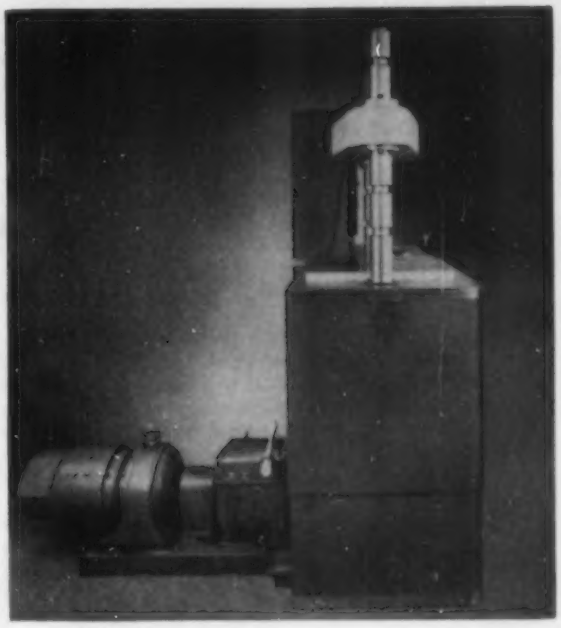
Basically, the instrument consists of a bed, slide, which carries the test gear, and a measuring slide carrier for the measuring slide and master gear. Bed slide and measuring slide carrier are mounted on a common base.

Interchangeable bed slides are available to adapt it to the inspection of various types of gears. The bed slide for spur gears carries an additional V-block which permits the testing of gears up to center distances of $5\frac{1}{2}$ in. A second type of slide is used for testing pinion shafts. A slide for bevel gears can be adapted by use of a tailstock fixture for the inspection of worms and worm gears, and by an angle piece for testing flat and round racks. For the inspection of assemblies of gears with shafts and bearings, the bed slide is removed, and the bed and measuring slide carrier used separately.

The gears are illuminated from below through a green glass window on the top of the work bench to which the instrument is bolted. This illumination enables the operator to see that the gears are meshing correctly, and thus helps in preventing any shock or pressure that might cause tooth deformation. If desired, a 30-horsepower microscope can be fitted on top for closer observation.

Kurt Orban Co., Inc., 205 E. 42 St., New York 17, N. Y.

Universal Tester Performs Many Jobs



The Model FGT, a machine of 50,000 lb capacity in tension and compression, is said to be the first production testing machine in which SR-4 resistance wire strain gages are used for load measurement. Loads are measured by means of two maximum-precision-type SR-4 load cells of 25,000 lb capacity each, at the base of two vertical tie rods. When equipped with suitable accessories the machine is capable of testing specimens of structural parts and components not only in tension, compression and flexure, but also while they are subjected automatically to alternating reversed loads, creep, stress, relaxation, torsion and shock.

The top platen is load sensitive and measures both plus and minus loads through two side rods each terminating in a 25,000 lb SR-4 Universal load cell connected totalizing into the output circuit. These load cells read out in a curve without dwell at the point of inflection.

The bottom platen applies load to any component fixed within the testing space by moving in either direction, up or down, through the action of a single reversing power screw driven by a variable speed motor of 2 hp. (Larger motor available for higher testing speeds). The variable speed motor covers a testing speed range stepless from 0.025 to 9.00 in. per min under control of a single potentiometer.

One of the new improvements provides greater flexibility of automatic load reversal. With the new load cycling system, it is possible to adjust control points by two load indicating dial knobs to any two loads between 50,000 lb compression and 50,000 lb tension. Cycling thus may be kept within the tension and compression range, or between any tensional and compressional load.

The rate of cycling depends upon strain amplitude within the machine's speed limits, which are normally 9 in. per min up to 10,000 lb load, 4 in. per min up to 30,000 lb load, and 2 in. per min up to 50,000 lb load. By special attachment to fit the platen opening of the machine, it is possible to apply loads to a specimen or part by mechanical means at rates of straining up to 100 in. per sec, and to record the stress-strain graph on an oscilloscope.

Load pacing is adjustable from dial capacity per min on any range down to 1/20th dial capacity per min in either direction. Strain pacing is adjustable from 0.00025 to 0.25 in./in./min in either direction.

A new stress-strain recorder of the SR-4 type is shown at the right of the dial indicator in the illustration below right. A wide variety of extensometers for varying magnifications and measuring ranges may be supplied. In the 0.505 in. dia 2 in. gage length extensometer there are magnification ratios of 50, 100, 250, and 500 obtained by selector switch, and a measuring range of plus and minus 5 percent of gage length. Thus, the extensometer can be used in tension and compression and is capable of drawing a graph of completely reversed cycles of tension-compression-tension. The extensometer is separable and can remain on the specimen while it fractures.

Accessory equipment available for use with the tester includes: torsion testing attachment; grips for sheet metal and wire specimens; a Brinell ball for hardness tests; thread end specimen holders for alternating load tests; equipment for high and low temperatures testing; and plastics and wood testing tools and fixtures.

Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

CONTINUED ON PAGE 216

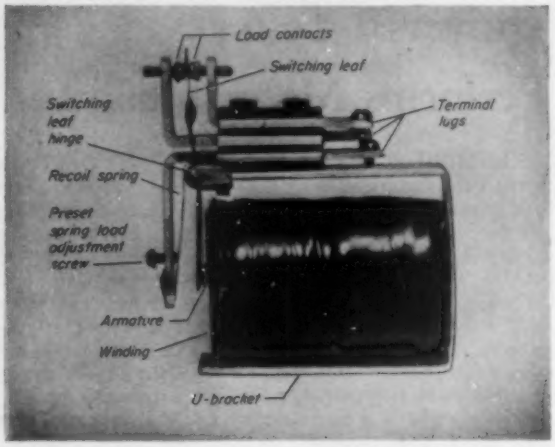
Wide Range, Super-Sensitive Relay

Available in SPST and SPDT switching action constructions, a new rugged, super-sensitive relay will, at its minimum power requirements, engage on as little as 0.25 milliwatts. From this limit as a low, the engagement demand can be continuously adjusted over the whole range to 5 milliwatts, and higher, as a "high."

One of the features is the fine adjustment over a wide range of its engagement demand to its drop-out demand. One extreme of this adjustment is a dropout which is 90 percent of its engagement demand, while the other extreme is a drop-out which is 20 percent of its engagement-demand. Even at its minimum engagement demand, this relay will withstand a 500 gr shock-force without false engagement or disengagement.

Because this type of service is available with 8,000-14,000 ohm coils, currents of approximately 0.0001 amp will serve to engage the relay at its minimum engagement power setting, while at its maximum power demand, the engagement current setting can be as high as 0.0005 amps and even higher at its minimum power demand level. The relay's load contacts are rated at 2 amp, noninductive, at 110 volts.

In all positions of the switching leaf, the engagement demand is fixed by the recoil springs pre-loading. An adjustment screw bearing on a cantilever flat spring that in turn loads the switching lead slightly above the leaf's hinge-point, determines the current level at which the switching leaf is engaged. Adjustments of the order of 0.1 gram per full turn of the adjustment screw are provided.



Techniflex Corp., Port Jervis, New York

Vibration Detector for Large Rotating Apparatus

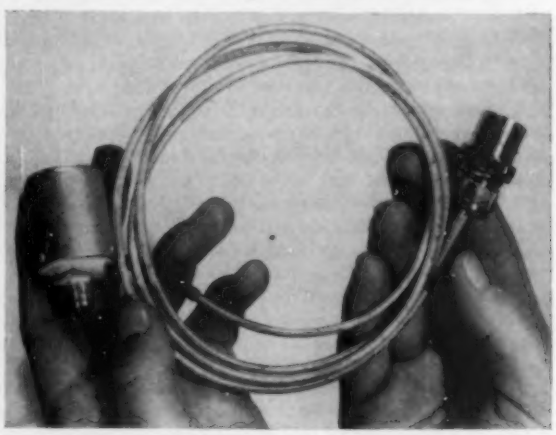
A highly sensitive, crystal-type accelerometer has been designed as a basic detection element for use in measuring vibration acceleration up to 50 Gs in large rotating apparatus.

Called the vibration detector, the new design meets requirements for use on turbine generators, large motors, blowers, steam and gas turbines, and centrifuges.

The device also has the light weight and high sensitivity needed for vibration studies of missiles and rockets. Critical elements such as the barium titanate crystal stack and components are shielded by a cup-shaped end mass which helps to guard against change of sensitivity in most corrosive atmospheres.

Sensitivity is approximately 0.9 v per G. Minimum lateral or torsional sensitivity, due to rigid support in these directions, helps provide reliable measurement. The output voltage of the detector is proportional to the acceleration imparted to the equipment on which it is mounted, but only in a direction perpendicular to the mounting plane. Auxiliary pieces of equipment required are a properly calibrated amplifier, a rejection filter, and an indicating instrument.

The six barium titanate crystals making up the stack, each of which is silvered to provide two electrodes, are cemented together with thermal setting cement. Connecting leads are soldered along each edge of the finished stack to insure positive electrical connection to the sensing element. This also eliminates the problem of changes in sensitivity due to corrosion of pressure-type contacts.



With a frequency response of less than 1 db rise at 1,000 cps, the accelerometer's lowest resonance is greater than 2,500 cps with a capacitance of 300 micro-micro-farads. The temperature effect on the detector is ±5 percent from —20 to +80 C.

The vibration detector like the one shown, weighs four ounces and is $1\frac{7}{8}$ in. high with a $1\frac{1}{16}$ in. diameter.

General Electric Co., 1 River Rd., Schenectady, N. Y.

CONTINUED ON PAGE 218

HERE'S PROOF: You can always count on Continental for every fastener need!

All Continental Engineers Have Produced Precision Tools!

. . . to better meet your specifications

Every engineer at Continental has had experience producing ground thread taps and gages, with their exacting screw thread dimensions. This training with highest standards of precision is passed on to you in every Continental product. The superior accuracy and greater thread uniformity more than meet your specifications, but cost you no more.

Many times Continental cold forged fasteners have been substituted for expensive screw machine products, improving the product by increasing its strength, while reducing its cost.

Put these standards of precision to work for you. Call direct or contact your local Continental distributor today.

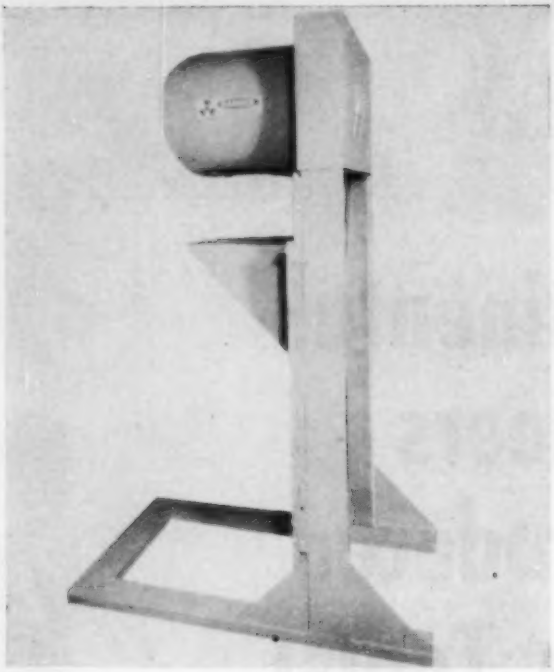
Manufacturers of HOLTITE Fastenings

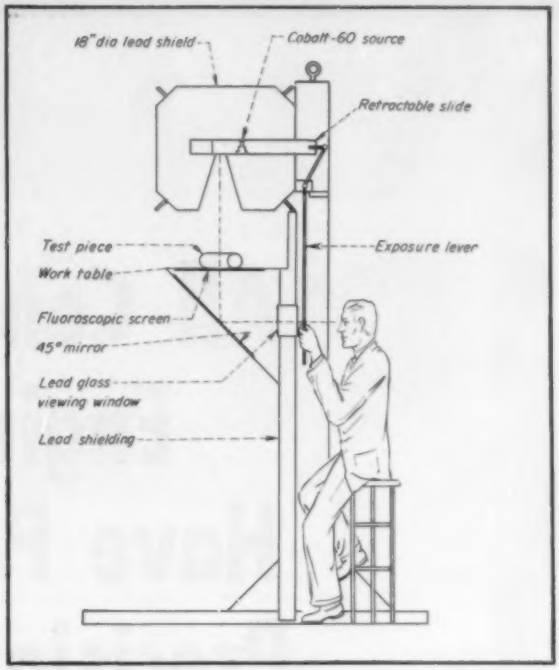
CONTINENTAL SCREW COMPANY INC. 1904

50th Anniversary

CONTINENTAL SCREW COMPANY

New Bedford, Mass., U. S. A.





Industrial Fluroscope for Non-Destructive Testing

An industrial type fluoroscope which uses gamma rays from radioactive isotopes rather than X-rays, and which is powerful enough so that only about $\frac{1}{4}$ of the radiations will be absorbed in penetrating $\frac{3}{4}$ in. steel, is finding application in foundry work and automobile manufacture, and has possible use in aircraft parts and assemblies inspection, according to the manufacturer.

The operator is protected against scattered radiation by the heavy (2 in. thick) lead shielding extending down the front of the machine to the floor. Viewing of the fluoroscope screen is possible through a 3 in. lead glass window and a 45 deg mirror.

The viewing screen which is mounted under the worktable is adapted for the passage of a conveyor belt beneath the radiating source. The large cobalt-60 source is contained in a steel cased 18 in. dia lead cylinder. It is mounted in a rectractable slide so that it is normally not exposed. On pulling the hand lever on the right side of the machine the source is projected forward above the conical opening looking down upon the worktable. See above, right.

One of the advantages of this gamma ray fluoroscope is its simplicity of operation and installation. Unlike an X-ray fluoroscope it is completely self-contained and requires no power or cooling water, has no tubes or transformers, generates no heat and has no moving parts. One-half the cobalt source will be decayed in 5 years.

For specific inspection tasks this basic assembly can be more completely shielded to protect personnel working in the area of the device. If a conveyor belt were to carry work across the worktable, the entire rear and sides of the machine would be enclosed and shielded with only a sufficient clearance allowed around the conveyor belt for the inspection pieces.

It will also be useful in the inspection of metal sections comparable to the range of $\frac{1}{2}$ to $1\frac{1}{2}$ in. of ferrous metals. The size of the fluoroscope screen is 12 x 12 in., and work pieces up to this dimension may be inspected. The fluoroscope stands 7 ft high and weighs 4,500 pounds.

Radioactive Products, Inc., 443 W. Congress, Detroit 26, Mich

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INSULATED WITH TEFLON, a line of magnet wire in a wide range of sizes for class H service or better and with good electrical properties, has a low loss factor, low dielectric constant (2—2.05 from 60 cps to 30,000 mc), and good dielectric strength, characteristics remain stable at temperatures from —100 to +260 C. The insulation is non-flammable. The solid conductor may be either soft or annealed copper on which the resin is dip-coated. Sizes range from 14-50 AWG in six colors. Single, heavy, triple or quad thicknesses are available. Present applications include: motors; generators; alternators and convertors; transformers, relays, and solenoids; delay lines, chocks, and filters. Hi-Temp Wires, Inc., 26 Windsor Rd., Mineola, L. I., New York.

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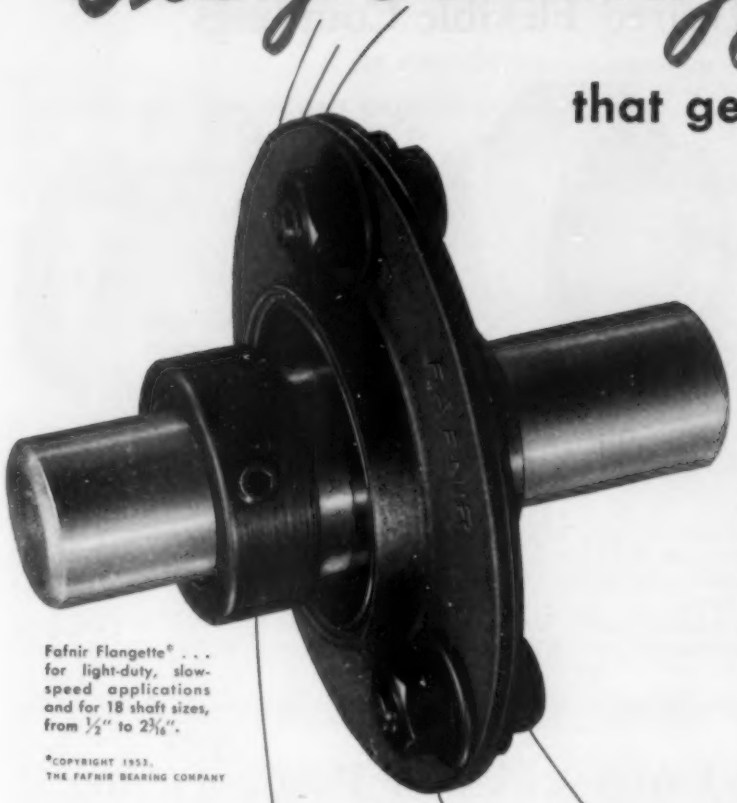
Design Strategy

that gets more for less



Fafnir Flangette® . . . for light-duty, slow-speed applications and for 18 shaft sizes, from ½" to 2 3/16".

®COPYRIGHT 1953, THE FAFNIR BEARING COMPANY

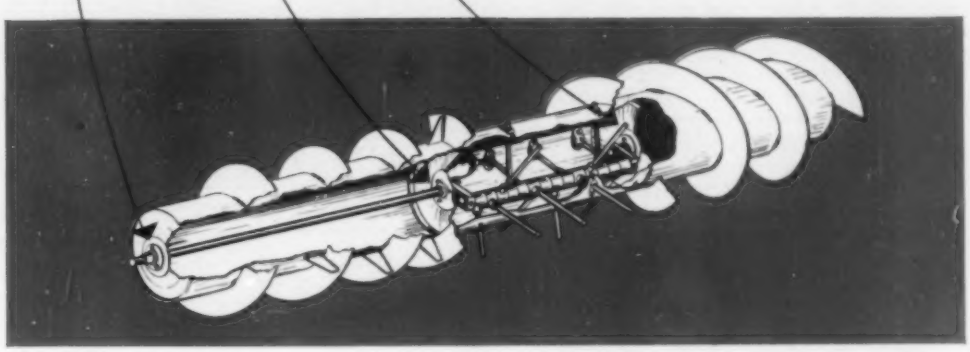
By installing Fafnir Flangettes on the loading auger shaft of a self-propelled combine, a manufacturer of farm equipment improved auger performance and reduced manufacturing costs at the same time.

Equipped with Fafnir Ball Bearing Flangettes, the auger required less power to operate, no re-lubrication, no bearing adjustments and its service life was extended substantially. In addition, whenever servicing of auger parts required disassembly and reassembly, Fafnir Flangettes saved important man-hours.

From a manufacturing angle, Fafnir Flangettes eliminated the need for fabricating bearing housings with attendant lubricating systems.

They have their *own* easily applied housings—paired pressed steel flanges, which enclose a self-aligning Fafnir Wide Inner Ring Bearing with Self-Locking Collar—easiest of all bearings to install.

The mated eccentric cam design of the bearing inner ring and collar provides positive locking action without set screws, locknuts, or adapters — eliminates shaft slippage or scoring. Efficient seals keep grease in — contaminants out.

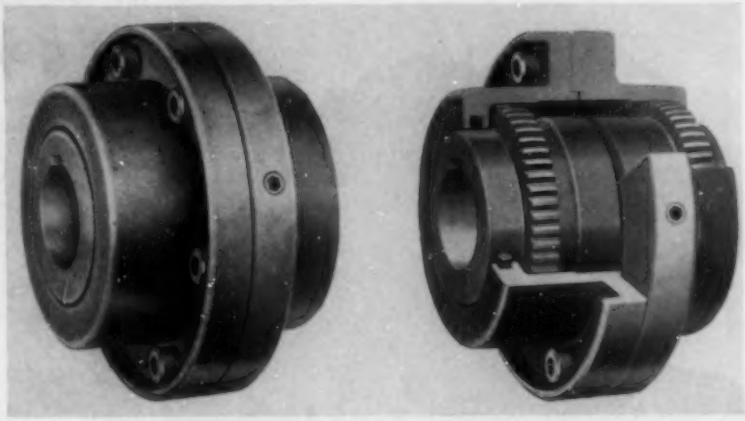


Here is another result of the Fafnir "attitude and aptitude," a way of looking at bearing problems from the designer's viewpoint . . . an ability for supplying the right bearing to fit the need. Maybe this combination can help you solve a bearing problem. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

High Capacity, Geared Flexible Couplings



Geared flexible couplings for high speed and high torque applications are available with bores ranging from 1 to 6 in., and with horsepower rating at 100 rpm, ranging from 2 to 450. Besides transmitting power efficiently, the couplings will accommodate a reasonable amount of shaft misalignment and end float. This is accomplished by the crowning of the externally cut geared teeth of the hubs to give clearance at the root of the internal teeth of the housing. Hubs bored for either slip or shrink fit can be furnished.

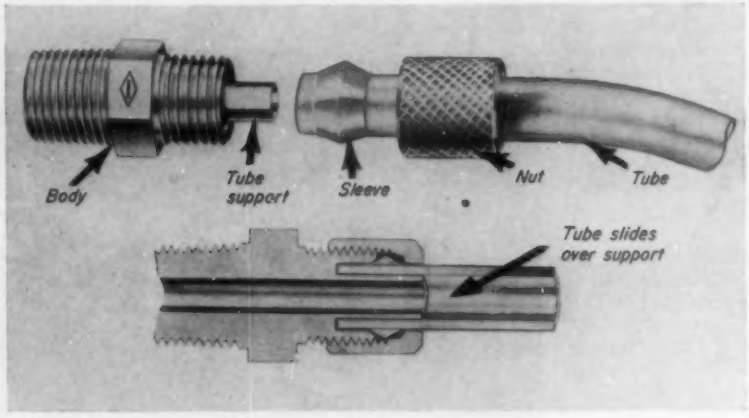
The housing, or sleeve, consists of a male and female section, each having internally cut gear teeth. The two sections, made from a special, heat-treated metal for added strength, are rabbet fitted and are bolted together to function as a single unit, forming a dustproof, lubricant-retaining enclosure.

The housing is free-floating, and assumes a neutral position with respect to the hubs when misalignment (whether angular, parallel or a combination of both) is present. Provision for misalignment is therefore furnished in the coupling with no increase of load on shafts or bearings.

Another feature is the wide face of the internal gear teeth to allow for end float of either one or both of the connected shafts while maintaining full tooth contact at all times.

Link-Belt Co.,
307 N. Michigan Ave., Chicago, Ill.

Tube Fittings and Accessories for Plastic Tubing



Poly-Flo tube fittings, for connecting polyethylene and other plastic tubing, are of the compression type and consist of a brass body with integral tube support, brass nut and polyethylene sleeve. The fittings can also be supplied in stainless steel for use with Teflon or other tubing. The integral tube support in the fitting supports the tubing in the sealing area, permitting the sleeve to grip it securely.

Ease and speed of installation are the main features, as the fitting need only be finger tightened, and tubing can be bent by hand. Fittings are now offered in two sizes, ¼ and ⅜ in. OD, with additional sizes available soon. Some of the styles furnished include unions, half unions, elbows, tees, and bulkhead unions. There are also unions that are used for connecting to metal tubing.

Joints will hold burst pressures in ¼ or ⅜ in. polyethylene tubing, of 400 and 350 psi respectively, and are recommended for working pressures up to 125 psi, in ¼ in. OD size and 100 psi in ⅜ in. OD size, and for temperatures from —90 to +175 F. Higher pressure and temperature limits apply when Teflon tubing is used.

A number of accessories are included in the line. One of these is a Kwik-Disconnect shut-off valve. This valve permits free flow in either direction through the valve when tubing is connected, but automatically shuts off flow when tubing is disconnected. This permits disassembly of a line without disturbing the balance of the piping system. Another accessory is a Poly-tube rack for holding tubing in an orderly manner when a number of tubes are involved; and a blow-down valve.

The Imperial Brass Mfg. Co.,
1200 W. Harrison St., Chicago 7, Ill.

CONTINUED ON PAGE 222

for Greater Strength with Lighter Weight

in modern material handling equipment

The increasing use of the Evans DF Loader reflects the progress of railroads toward more efficient material handling methods.

In the DF Loader there is high strength with minimum weight through the use of N-A-X HIGH-TENSILE steel. This low-alloy steel has 50% greater strength than mild carbon steel, with greater resistance to corrosion with either painted or unpainted surfaces.

You can get the same results as Evans. Your product can be made stronger, lighter in weight and longer-lasting, when you specify N-A-X HIGH-TENSILE steel.

N-A-X HIGH-TENSILE STEEL

THE EVANS DF LOADER is a product of Evans Products Co., Plymouth, Mich. DF means Damage-Free, Dunnage-Free.

NAILABLE STEEL FLOORING for boxcars, flatcars and gondolas is made of N-A-X HIGH-TENSILE steel, and is a product of Steel Floor Division, Great Lakes Steel Corporation.

Engineering data on these products available upon request to the manufacturers.

The "Wonder Bar," a section of which is shown at left, is a vital part of the Evans DF Loader. It is a wooden bar reinforced by a Z-bar made of N-A-X HIGH-TENSILE.

The "Wonder Bar," when locked into place, secures all kinds of lading. It is strong enough to resist shifting load stresses in moving boxcars, yet so light that one man can lift it into position. The DF Loader provides real operating economies for both railroads and shippers.

Another modern product for efficient transportation equipment is Nailable Steel Flooring, also made of N-A-X HIGH-TENSILE steel.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division — Ecorse, Detroit 29, Mich.

NATIONAL STEEL CORPORATION

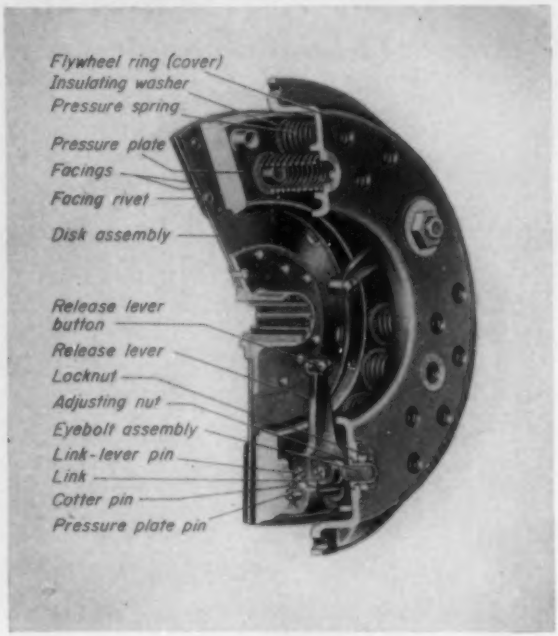
Non-Adjustable, Direct Pressure Clutch

This heavy-duty, non-adjustable, DP (direct pressure) clutch, designed as a compliment to the ML adjustable clutch, offers two design advantages—rugged structure and broader interchangeability with other direct pressure clutches. This has also been combined with high torque capacities, minimum parts, low release loads, and positive engagement to provide for extra heavy-duty and to meet the demands of applications which require the non-adjustable feature. In addition, the DP clutch, which is of the dry-disk push-type construction, has been designed to minimize periodic inspection, maintenance, and replacement deadlines.

Regular automotive clutch pedal adjustments are applicable, when necessary, to maintain proper clearance between the clutch release bearing and the release levers on the new DP clutch. By means of driving lugs in the flywheel ring and mating slots in the pressure plate, the clutch flywheel ring, which is attached to the engine flywheel, drives the pressureplate. A series of springs, arranged in three groups on the pressure plate provide plate pressure on the driven disk assembly. The movement of the pressure plate during engagement or disengagement is controlled by a release lever located between each group of springs. To provide long wear resistance, the end of each release lever is capped with a hardened button.

The pressure springs expand and exert pressure against the driven disk plate through the pressure plate. The construction of the pressure plate and the distribution of pressure springs transmits torque efficiently and smoothly, and evenly distributes heat and wear on the friction area.

Both single and double plate sizes of the new clutch are to be available ranging in the single plate size from 12 in. through 15 in., plus a 17 in. size, and in double plate models in 14 in. and 15 in. sizes. Three sizes will supply ample torque capacities for engines developing from 200 to 1,400 ft-lb of torque. Although non-adjustable and no internal adjustment is required, an internal clutch adjustment on the new clutch has been included for rebuilding purposes, or when refacing the pressure plate, to restore the original lever for full facing wear.



Lipe-Rollway Corp., 712 Emerson Ave., Syracuse, N. Y.

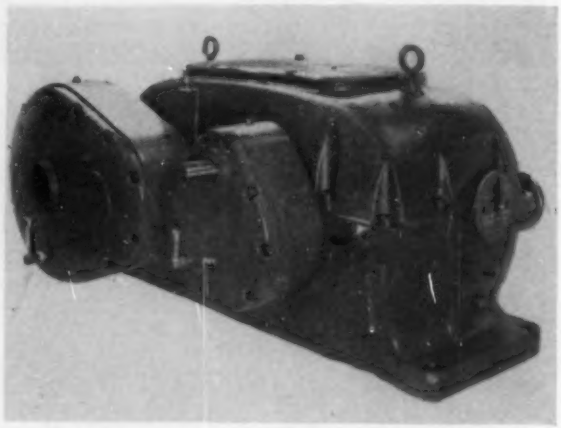
Stepless, Variable Speed Control

Positive, infinitely variable speed drives are now available in two new types for 20 to 25 horsepower applications. In addition to the H-6 P.I.V. of 25-hp capacity, an HG-6 drive, furnished with either a single reduction input or single reduction output helical gear attachment, or an HGG-6 drive, furnished with both single reduction input and output helical gear attachment, is available.

Input gear reductions are supplied from 1.93:1 minimum to 5.82:1 maximum, and output gear reductions from 1:1 to 6.33:1. Speed increasing gear sets are also available.

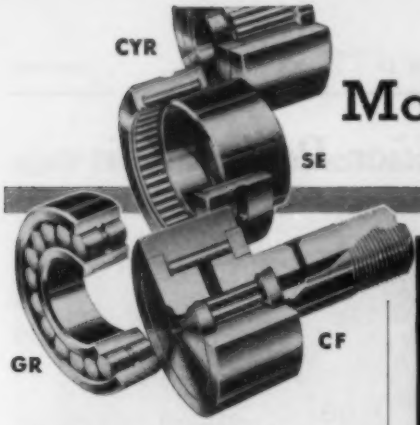
The complete line includes drives in eight sizes, ranging from ½ to 25 horsepower capacity, with ratios up to 6:1, in 16 types, for horizontal and vertical mounting, with and without helical gears and integrally mounted motor.

Applications of the new drive include: exact synchronization and timing of operations; metering and proportioning; control and infinite variation of machine or conveyor speeds; speed changing under full load by manual, automatic or remote control. The automatic controls can be electronic, hydraulic, pneumatic or mechanical.



Link-Belt Company, 307 N. Michigan Avenue, Chicago 1, Ill.

CONTINUED ON PAGE 224

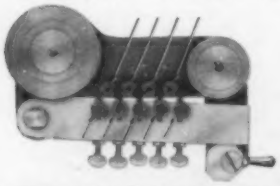


McGILL BEARING BRIEFS

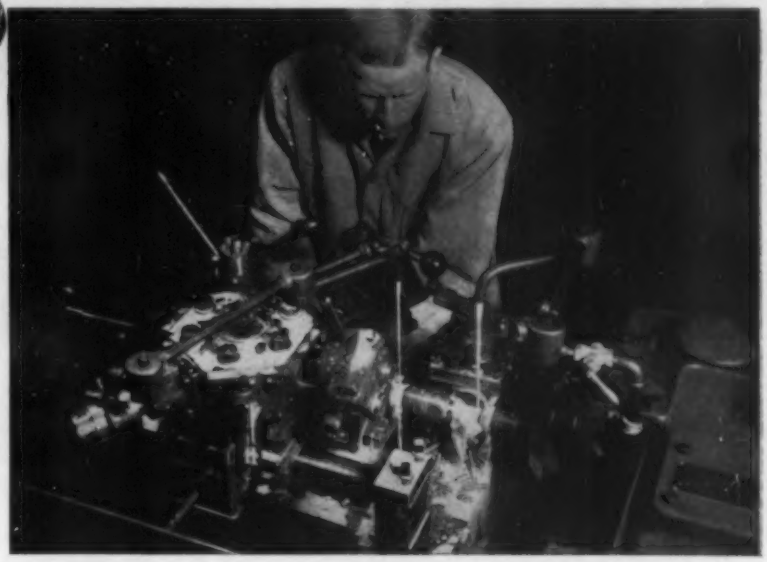
MULTIROL CF BEARINGS PROVIDE POSITIVE CAM ACTION IN ANCHOR CUT-OUT

Anchor Steel and Conveyor Company relies on Multirol Cam Follower Bearings for positive and instant operation of Anchor cut-out couplings. When dangerous overload occurs this torque sensitive coupling cuts power when a spring loaded sliding sleeve is actuated by forcing CF series bearings up the inclined faces of a circular cam. Shock load capacity and dependability of CF series bearings combine to help the Anchor Company protect motors and machinery from damage due to overload.

SJOGREN KILLERS CAST WIRE ON MULTIROL CF BEARINGS



On Sjogren Killers for casting wire, Multirol CF bearings with outer races grooved to required wire size have replaced hardened steel rollers. Sjogren maintained required accuracy at much higher casting speeds with minimum of grease instead of objectionable oil lubrication.



Warner & Swasey Uses MULTIROL® CF Bearings as

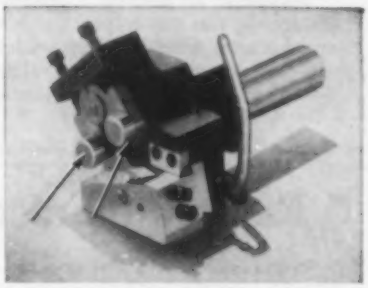
STEADY REST ROLLERS ON TURRET LATHES

The precision turning done on Warner & Swasey Turret Lathes depends to a great extent on providing adequate, accurate and free turning support for the work in process. The pressure of the cutting tool must be backed up on the end opposite the chuck so that depth of cut and concentricity remains constant.

This support is provided with tool holders using two Multirol Cam Follower bearings as steady rest or bar turning rollers. The precision quality of these rolls is very important to efficient operation. Free turning rolls of adequate capacity will assure work with a smooth finish and a high degree of accuracy.

Warner & Swasey have been using Multirol CF Series bearings in this application for over 15 years. They adopted the McGill bearing after finding its precision quality, resulting from close radial tolerances, ideal to help insure superior lathe performance.

The outer ring of Multirol CF Bearings operates on a full complement of small diameter rollers so the load is



evenly distributed over a greater bearing surface. The inner race and flange are made in a single piece with the stud, preventing any possibility of disassembly. Close tolerance grinding of all bearing surfaces insures greater accuracy throughout longer bearing life and, compared with plain bearings, lubrication is simplified and less critical. Both starting and rolling friction are reduced to a minimum. As a result, internal wear is diminished and power requirements of Multirol bearing equipped machines are cut appreciably.

BEARING SELECTION GUIDE
A new 140-page Bearing Selection Guide, complete with 30 pages of vital engineering data, has been released by the McGill Manufacturing Co. Ask for Catalog No. 52.

McGILL® — **Precision Bearings**
McGILL MANUFACTURING COMPANY, INC.
201 N. Lafayette Street, Valparaiso, Indiana

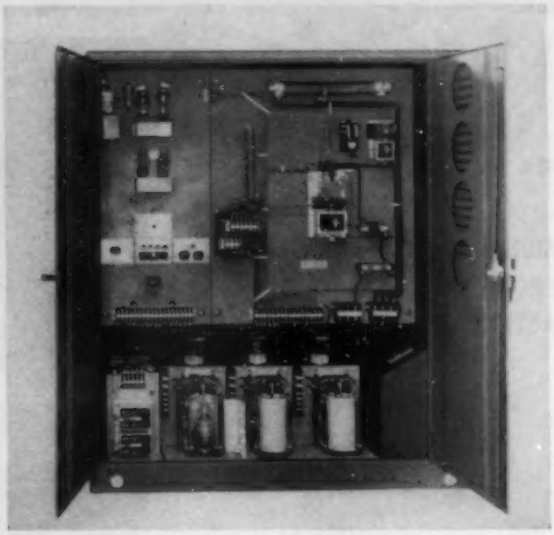
Adjustable Speed Mercury Rectifier Power Drive

Development of a new mercury rectifier variable-voltage power drive designed for a range of industrial applications requiring adjustable-speed service, has resulted in the new unit shown, called the Xatron V*S drive. Features are: wide speed ranges; smooth starting; stepless acceleration; close speed regulation; fast response; high overload capacity; centralized control; power applied directly; quiet operation; saving in space; and minimum maintenance. The drive unit uses mercury arc rectification with a new single anode mercury pool rectifier tube called the Xatron.

The first size of air-cooled Xatron rectifier available, operating in a three-phase bridge arrangement, provides conversion suitable for 30, 40 and 50 hp drives. The control units are substantially lighter in weight than control units including rotation conversion equipment.

Control unit of this adjustable-speed drive incorporates six single anode air-cooled mercury tubes. Each Xatron is arranged as a unit with its respective saturable reactors, magnet, and exciting bank, and is well-shielded. Operating from a 3-phase power supply with a full-wave bridge to give a six peak d-c output, the tubes are grid controlled by an electronic phase-shifting circuit. Assembled as a unit mounted on a base, which also serves as an air-pressure chamber for a blower supplying filtered cooling air, they are pre-wired, inter-connected back-to-back and three on a side, and arranged in individual L-shaped panels located over the air chamber. The Xatron depends not on coated surface for electron transmission, but on mercury vapor.

Because of an inherent 5 percent or better regulation at all speeds, this power package is said to provide greater speed ranges. Output voltage of the grid-controlled Xatron can be held accurately at low values; the problem of residual voltage encountered in rotating conversion is eliminated. However, for continuous operation at low speeds, the drive motor requires seperate continuous ventilation.



Speed ranges for the 30 hp rating are: 220/1750; 220/2300; 145/2300; 105/1700. Speed ranges for the 40 hp are: 220/1750; 220/2300; 145/1750; 105/1700. Speed ranges for the 50 hp rating are: 220/1750; 220/2000; 145/1750; 105/1700; and 85/1380.

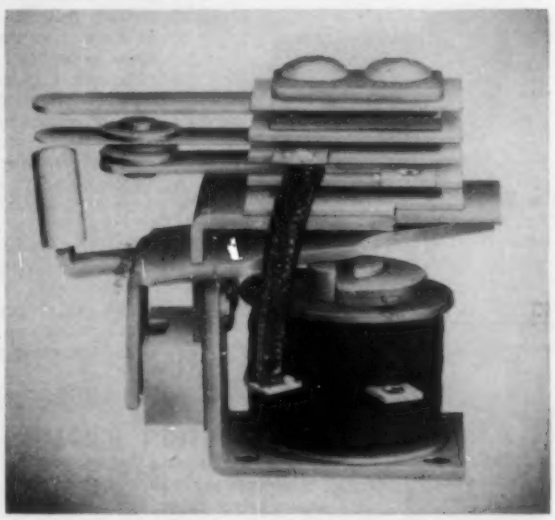
Reliance Electric & Engineering Co.,
1088 *Ivanhoe Rd., Cleveland* 10, *Ohio*

Relay for Fractional Horsepower, Split-Phase Motors

Voltage operated, a new type MS relay for use with fractional horsepower split-phase motors can be used in certain applications where operating conditions make the conventional centrifugal switch undesirable. When mounted in a dust-tight, gas-tight enclosure, it prevents interference from foreign matter and also reduces hazard of explosions from centrifugal switch arcing.

Among its characteristics are: cut-out, nominal operating range 120 to 130 v, a-c; cut-back, nominal range 50 to 70 v, a-c; positive toggle provided by alnico magnet; no hinges to wear in toggle; silver contacts $\frac{3}{8}$ in. dia; low loss (approximately 3 V.A.); operates in any position; full quarter inch creepage path between mutually insulated parts; overall size, $2\frac{3}{16}$ in. x $1\frac{13}{16}$ in. x $1\frac{1}{8}$ in.; weight, about 4 ounces.

The relay can be supplied with coils for other voltages or for d-c. It is also available as a conventional relay with 1 Form C spring assembly. However, for general relay applications this unit is generally furnished without the toggle magnet for increased sensitivity.



Sterling Engineering Co., Inc., Laconia, New Hampshire

CONTINUED ON PAGE 226

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Every month Product Engineering lists scores of new catalogs and bulletins available from manufacturers. Some of these cover features of specific equipment. Others contain detailed technical information on selection and application of broad classes of products. All are available to you for the asking.

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To save you time in making such requests, simply use one of the attached post cards.

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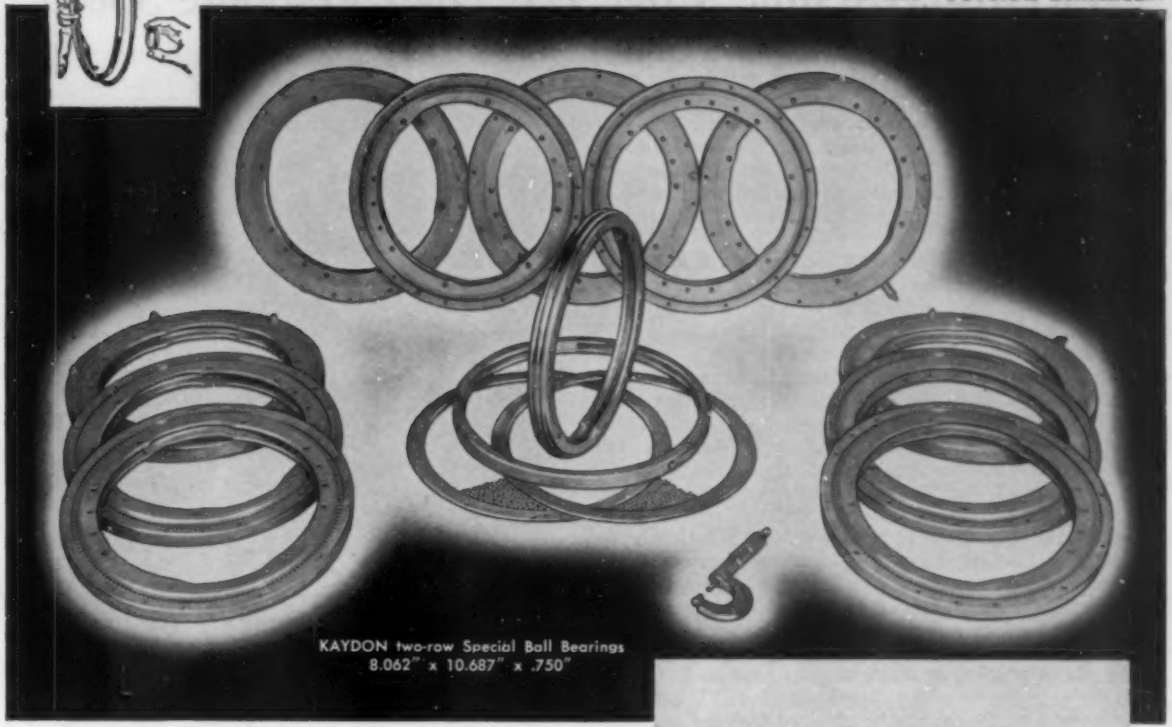
Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



KAYDON two-row Special Ball Bearings
8.062" x 10.687" x .750"

Dependable Life-Savers ...KAYDON-bearinged Piasecki HELICOPTERS

CONTROL movements of Piasecki HUP Helicopters . . . life-savers of the air . . . are transmitted to the spinning rotor blade assemblies by means of a swash plate that moves on unique two-row KAYDON Special Ball Bearings.

Control of the helicopter is obtained by the movement of its rotor blades. Each blade can move in six different directions while they are rotating. Thus the mechanism responsible for control movements is complex, important, and it demands the utmost in bearing-precision.

KAYDON met the challenge of this intricate bearing-problem with these special two-row, thin section, 8.062" x 10.687" x .750" ball bearings. Similarly, KAYDON cooperates with designers of many types of precision equipment to achieve their objectives.

We specialize in large, thin-section, light weight precision bearings for Aircraft, Automotive and Industrial Equipment

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

Electro-Hydraulic Valve Has High Response Speed

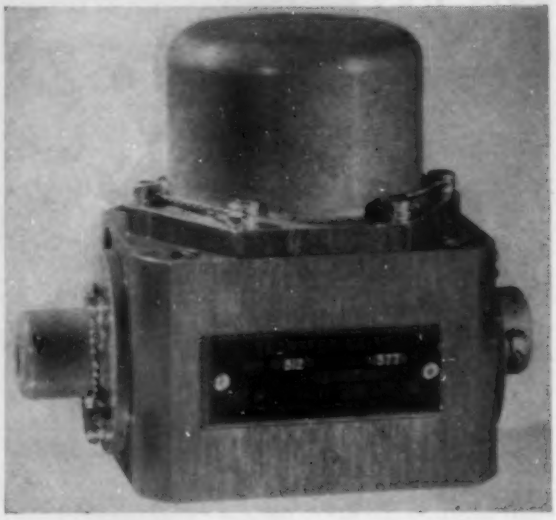
High speed of response and accuracy are provided by a new electro-hydraulic servo valve which consists of a group of proportional type, electrically actuated hydraulic four-way valves featuring no mechanical linkage. These valves are designed to control any maximum desired output flow from 0.5 to 8.0 gpm in hydraulic systems from 1,000 to 3,000 psi. Standard signal input for full output flow is a differential current of ±8.0 milliamp, with lower or higher signal levels available.

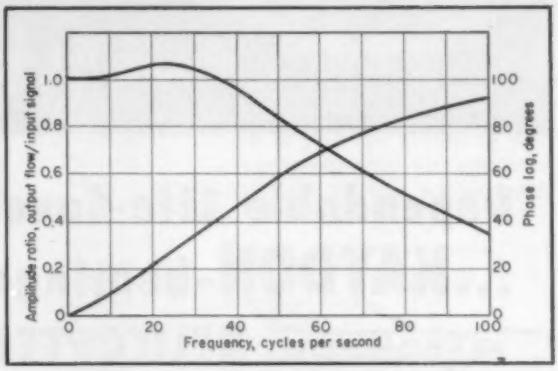
The model 500 valves have a frictionless first stage push-pull hydraulic amplifier which requires a continuous oil flow of 0.1 gal per minute. This oil is internally filtered by sintered bronze elements and magnetic traps. The input is a polarized solenoid which is motivated by a coil. The output of the first stage is a differential hydraulic pressure which is applied to the valve spool in opposition to the valve spool return springs. This method of valve operation results in high level spool driving forces which minimize spool friction and acceleration forces.

These small lightweight valves are used in control systems requiring high accuracy such as machine tools, paper making and textile machinery, and other processing equipment; or requiring high speed of response such as automatic packaging machinery, aircraft and guided missiles. Normally the valve input is from a balanced push-pull d-c amplifier, and the valve output flow is applied to a piston or hydraulic motor. An electrical signal proportional to the piston position or motor angular rotation is fed back to the amplifier to give a closed servo loop. Loop natural frequences of 65 cps can be obtained with an uncompensated amplifier.

Specifications include: weight, 0.8 lb; linearity tolerance, ±5 percent; gain tolerance, ±10 percent; threshold (percent full signal) 7½ percent; maximum spool leakage at zero signal, 2 percent of rated flow. The valve body is constructed of aluminum alloy. The floating type bushing and spool assembly are made of hardened steel.

The Moog Valve Co., Inc., Proner Airport, East Aurora, N. Y.





Sequence Relay with Release Operation

An inexpensive midget sequence relay with a variety of DP-ST and DP-DT contact arrangements is finding widespread use where a predetermined cycle of operation is needed.

Known as Frame 211, the new relay has a unique double cam movement that permits the contacts to be adjusted to operate when the coil is deenergized when so specified. The cam rotates a half step when the coil is energized, and completes the step when deenergized. The manufacturers claim that the ability to transfer contacts on either the "operate" or "release" phase offers sequence arrangements never before practical in a simple unit. For instance, "make before break" between two contacts would be more positive than usual by overlap during the time the relay is energized.

Frame 211 relays are equipped with DP-ST or DP-DT contacts which may be set to open, close or transfer in any desired sequence, providing the number of steps in a complete cycle is divisible into six or eight, (the number of teeth on available ratchets).

All commonly used continuous duty coils in ratings up to 115 v d-c or 230 v a-c, can be supplied. Power consumption is 5 to 6 watts, d-c, or 10 to 12 v-amps a-c. Special coils are also available.

Contacts are fine silver convex buttons, mounted on phosphor-bronze flexing arms for long life. Contacts are rated at 5 amps a-c; or 0.5 amps d-c at 115 v; and 5 amps d-c at 24 volts.

Molded spacers lock the contacts into position and provide 150 v insulation. Contact spacers and pushers are of moisture resistant phenolic and the ratchets and cams are of nylon.

Struthers-Dunn, Inc., 150 N. 13th St., Philadelphia 7, Pa.

CONTINUED ON PAGE 228

dig this powerful ditcher

PHOTO COURTESY BARBER-GREENE COMPANY, AURORA, ILLINOIS

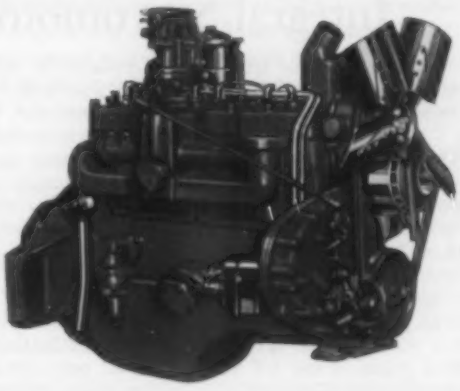
Chrysler *power and gýrol Fluid Coupling team up to put the "run" in runabout.*

When the operator of this ditcher "lowers the boom" things happen fast. That's because the vertical boom concentrates the weight of the unit on the work, bringing additional pressure to bear on digging buckets. This, in turn, allows them to bite into practically any kind of ground formation, frozen soil or even bituminous pavement. Upon completion of digging, a simply-operated hydraulic control raises the boom and the unit takes off—automotive style—down the highway to the next job.

Behind the power and dexterity of the Barber-Greene Runabout is the Model 8 Chrysler Industrial Engine and Chrysler gýrol Fluid Coupling. This 250 cubic inch displacement engine with its wide speed range drives the bucket line, crowds the ditcher along the trench, supplies power to the hydraulic boom hoist and takes the ditcher to the next job at traffic speeds. Chrysler gýrol Fluid Coupling helps the operator coordinate crowding and bucket line speeds for maximum digging efficiency.

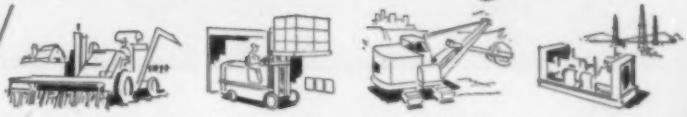
If your equipment requires power within our 217 to 413 cubic inch displacement range, engines that will operate equally well with gasoline, natural or L-P gas fuels, engines ideally suited to power take-off, then see a Chrysler Industrial Engine Dealer. He can supply *engines equipped at the factory for their jobs in the field.*

Remember too that Chrysler Power is not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. If you prefer, write: ***Dept. 52, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***



CHRYSLER *Industrial Engines*

HORSEPOWER WITH A PEDIGREE



AGRICULTURE • INDUSTRY • CONSTRUCTION • OIL FIELDS

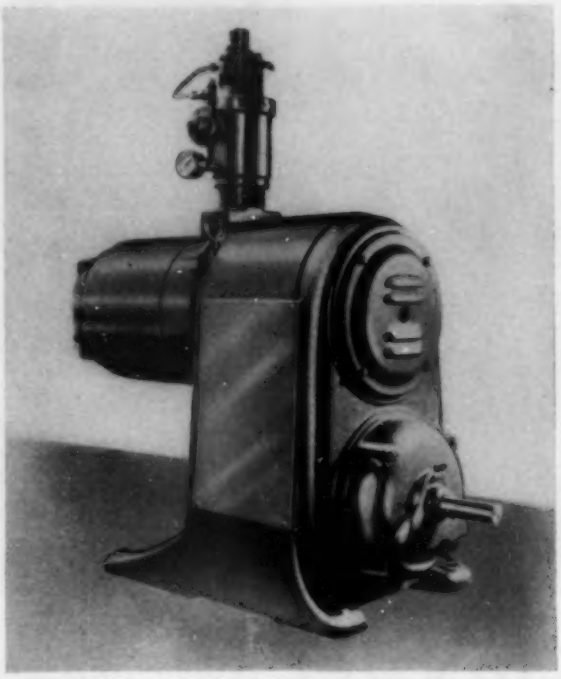
Pneumatic Control of Variable Speed Drive Unit

Automatic speed control of Varidrive motors, made by this company, by such variables as pressure, temperature, speed or liquid level is now possible through a development of an improved pneumatic control called the Varitrol, which may be operated either manually or automatically.

Designed to operate on a supply of air pressure of 60 to 100 psi, the Varitrol is controlled by an air cylinder using air on both sides of the piston for positive positioning. A small, sensitive positioner operating on 3 to 15 psi signal air, controls a pilot valve regulating the power air to the air cylinder. The signal system to the positioner may be any one of the standard control instruments now in use for control systems. Because the type of signal system needed will depend upon the particular application of the customer, only the power system is supplied with the Varidrive.

A feature of the new control is the approximate straight line relationship between signal pressure and speed. This feature is a result of the right-angle speed changing linkage of the varidrive, which, combined with the characteristics of the pneumatic system, permits its use on such applications as proportioning controls. An additional value of the straight line relationship is a uniform sensitivity of the control over the entire speed range.

Typical types of control equipment which may be used on this pneumatic system are: manual speed control, with Varidrive speed set from a remote manual dial; pressure control, varidrive speed varied to maintain a constant pressure; pressure control, varidrive speed proportional to pressure; temperature control, varidrive speed proportional to temperature; liquid level control, varidrive speed regulated to maintain constant liquid level in tank or reservoir; speed control, varidrive speed kept constant with changing line and load position; and proportional flow control, where the speed of the varidrives is regulated by the flow of liquids through a Venturi or orifice meter or where the material is passing on a belt conveyor over a weighing scale.



The advantages of the pneumatic control system include simple construction, adaptability to many types of signals, sensitivity and stability, ease of installation and servicing, and the explosion-proof characteristics.

Varitrol is presently available on varidrives from 1 to 30 hp and can be supplied up to 50 hp.

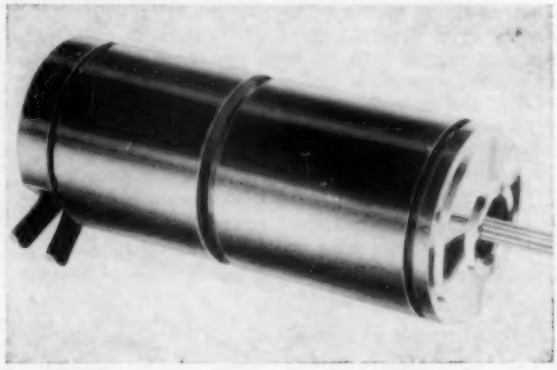
U. S. Electrical Motors, Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

Integral Servomotor and Damping Generator

A compact unit for servo system applications, this two-phase servo motor and integral damping generator provides optimum performance without sacrificing small size. Weighing 7.6 oz, it is 1.062 in. dia and 3 in. overall length.

The stator assemblies of both motor and generator sections are integrally cast in a thermosetting plastic material. This method of construction offers a structure permitting straight through rotor bores, and minimum air gaps with a resultant increase in performance.

Average characteristics. Motor data—excitation: 115 v, 400 cycle—fixed phase; 57.5 v, 400 cycle-center tapped control phase; draws 3.5 w. For plate-to-plate operation; 180 v, 400 cycle-fixed phase; 90 v, 400 cycle-center tapped control phase, draws 3.7 watts. Output: rotor inertia 1.3 gm cm^2; stall torque, 0.63 in.-oz; no load speed 5,900 rpm.; theoretical acceleration at stall, 34,200 rad/sec^2. Generator data—excitation: 115 v, 400 cycles. Output: 0.500 v per 1,000 rpm; output impedance 600 ohms; null voltage 19 mv; and maximum speed for linear output 5,500 rpm.



Kearfott Co., Inc., 1150 McBride Ave., Little Falls, N. J.

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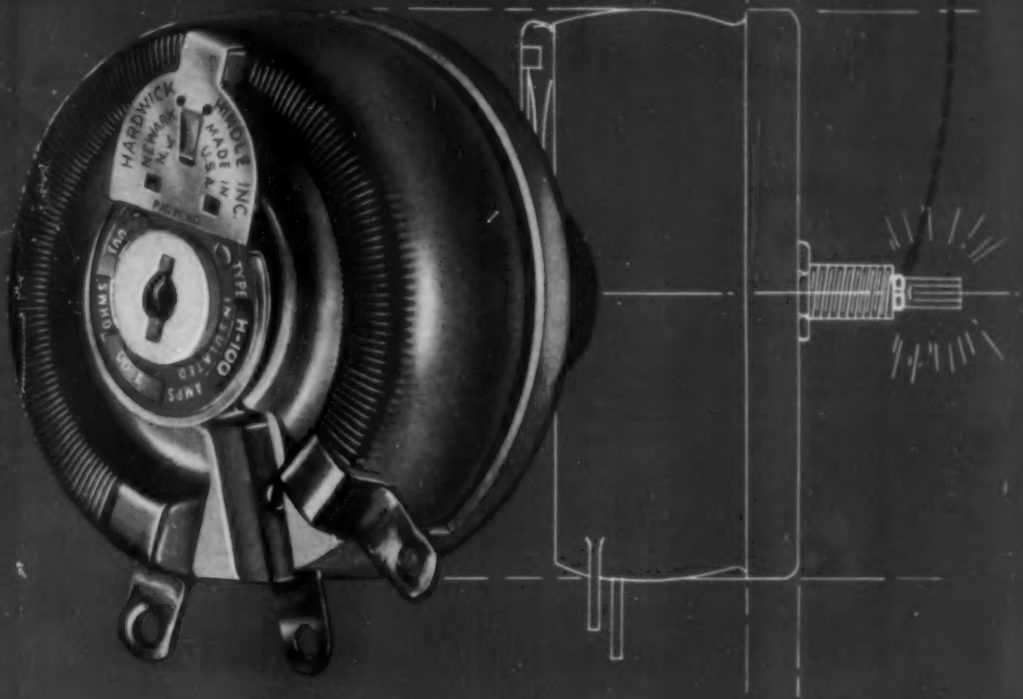
Let a simple retaining ring save metal and money for you!



Retaining rings saved material and assembly time on this finely made rheostat. They continue to save money both for Hardwick Hindle—the manufacturer—and for its customers.

Looking at this application you may say it was obviously a "natural", but there are literally thousands of cases where retaining rings can save as much or more.

Examine *your* machines and products to see where the use of these inexpensive modern artificial shoulders can cut your costs too.

It is needlessly expensive and wasteful to hold a mechanism in place with unnecessarily big shoulders or collars, or to temporize with small cotter pins etc., etc.

Let us show you how these high grade steel rings can do a thoroughly efficient job, saving money for you as well as for your customers.

More and more applications of retaining rings are being made every day.

Write today for descriptive folder.

THE NATIONAL LOCK WASHER CO.

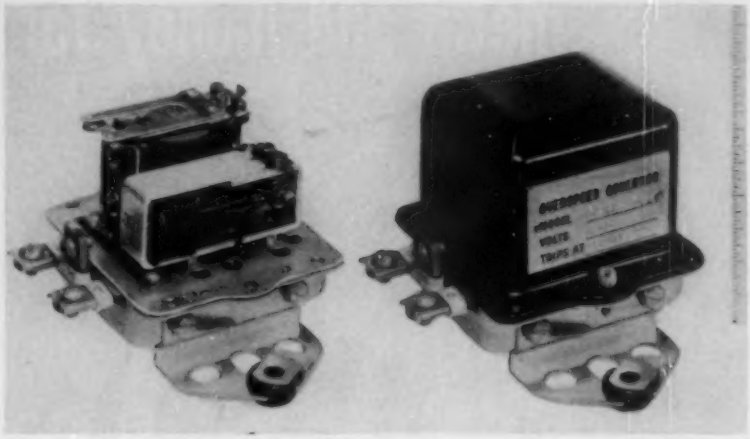
NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN, U. S. A.

Governor for Overspeed and Frequency Protection

This all electric governor requires no mechanical connections to the engine or device to be controlled. It can be mounted at any convenient place, in any position, and in a mounting space less than 6 in. square. The industrial model weighs less than 2 lb and the aircraft type only 11 ounces. They can be furnished to take their frequency reference from an a-c alternator, either 60 or 400 cycles; from a small tachometer generator; or from the ignition breaker points on a gasoline engine.

The frequency sensor consists of a tuned vibrating reed driven by an electro magnet connected to the frequency reference. When this frequency reference resonates with the fundamental mechanical frequency of the reed, the latter vibrates and closes contacts to pull in a control relay. The energy required for operation of the reed is less than one watt, and the resonate frequency can be calibrated to one percent.

Standard models are furnished with single pole double throw contacts to open a circuit or close it as required at the preset frequency point, and is



available for either automatic or manual reset. Industrial models are sealed against dust and splash, but where required for explosion proof or aircraft use, they are obtainable in hermetically sealed cans.

Applications include engine overspeed protection, over frequency cut off on generator sets, alarm lights for over and under frequency conditions, automatic synchronizing, sequence control for turbo starting and circuit breaker or transfer switch operation at exact frequency. These governors are not effected by vibration, shock, humidity or altitude, and are said to outlive the device protected.

Custom Built Controls, Electro Governor Div.,
1801 *Rand Rd., Des Plaines, Ill.*

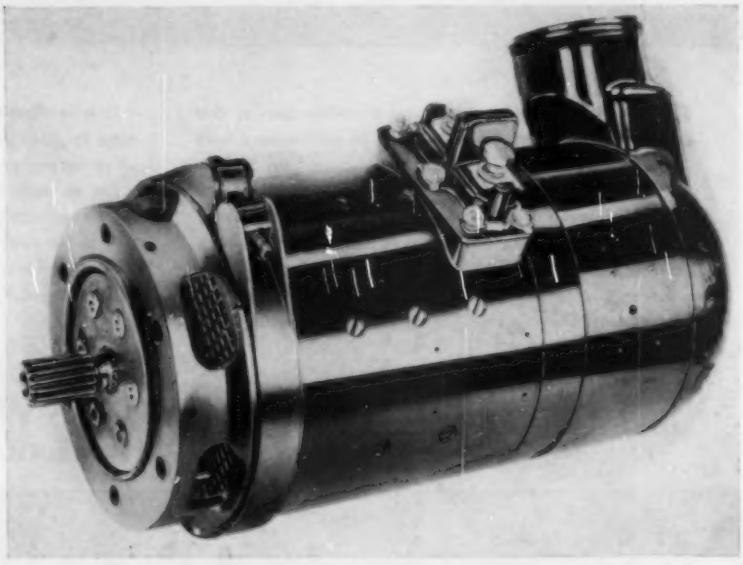
High Speed, Aircraft D-c Generators

Three high-speed d-c generators, all of the 8,000 rpm continuous duty type, for use with jet engines have: (1) the elements capable of withstanding higher operating temperatures; and (2) increased heat transfer areas.

G123: This unit will supply 300 amp at 30 v with a speed range of 3,000-8,000 rpm. The generator has a 3 in. dia air inlet and requires cooling air at pressure equivalent to 6 in. water. Overall dimensions are $13\frac{7}{8}$ in. length and $6\frac{1}{2}$ in. diameter.

G124: This unit will supply 400 amp at 30 v with a speed range of 3,000-8,000 rpm. The generator has a 3 in. dia air inlet and requires cooling air at pressure equivalent to 6 in. water. Overall dimensions are $13\frac{5}{32}$ in. length and 8 in. diameter.

G128: This unit will supply 400 amps at 30 v with a speed range of 3,100-8,000 rpm. The generator requires cooling air at pressure equivalent to 12 in. water. Dimensions are $14\frac{3}{4}$ in. length and $6\frac{1}{2}$ in. diameter.



Jack & Heintz, Inc., 17598 Broadway, Cleveland 1, Ohio

CONTINUED ON PAGE 232

No sir . . . They're OK hardened bedway cross sections!

These hardened ways, made by The Ohio Knife Co., give you an idea of the diversified shapes and sizes supplied. OK's special process of manufacture permits building to your specifications in a wide range of design.

Specially heat-treated tool steel makes OK ways practically wear-proof and helps maintain constant accuracy throughout the life of the machine. This extreme hardness, 65-66 Rockwell "C," is uniform to 3/16-inch depth or more.

Through the Ohio Knife process the long-wearing tool steel is welded to a soft steel backing under 2500 tons pressure. Then precision equipment finishes the bedway by grinding to tolerances up to ± .0002 inches.

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO

Write today to Dept. B for comprehensive bulletin, or send us your bedway specifications.

Manufacturers for the metalworking industry of:

SLITTER KNIVES • SHEAR BLADES • BRONZE WAYS
ROTARY SHEAR KNIVES • HARDENED SPACERS
HARDENED WAYS • BALL RACES
WEAR STRIPS • GIBS

Directional Control Valves for Mobile Equipment

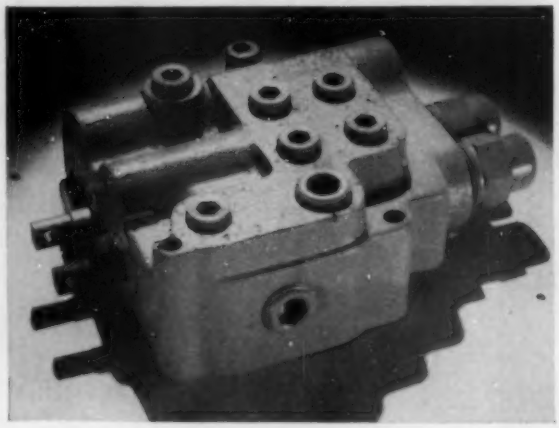
The flexible design of a new complete series of directional control valves for mobile equipment allows flow characteristics to be tailored to the user's needs. According to the manufacturer, the new spool slot design puts the valve series in the ultra-smooth operating class, with the spool groove being coined straight down in a V-slot to permit accurate position control and smooth metering action. There is full metering in all spool porting. The valve was designed to meet the trend toward higher pressures, increased fluid velocities, and accelerated operating speeds on mobile equipment.

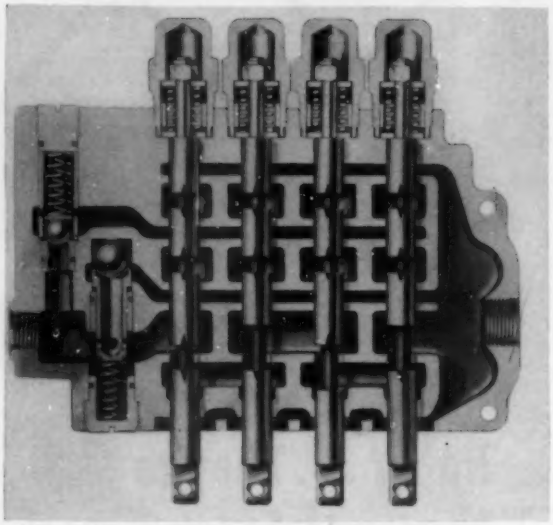
The V-slot groove defines a fixed percentage of increase or decrease in fluid velocity to the linear increment of spool movement. Tests have revealed that the smooth metering eliminated shock loads on hydraulic systems and consequent shock loads on mechanical parts. In addition, it offers a simplification of operator control on mobile equipment.

The new valve was designed in four sizes to allow flow of 8, 16, 23 or 35 gal per minute. There are 1, 2, 3 and 4 spool models, with the single and double acting spools being interchangeable. In the smaller sizes, the device can control pressures up to 2,500 lb per sq inch. The full parallel circuit permits exact travel control in more than one direction and several operations can be done at one time. It is adaptable to simultaneous rotation, fork clamping, side shifting and up-ending operations. Smooth fluid flow pattern from the pump to the cylinder ports yields accurate positioning control and positive hold. Travel speed is completely controlled with the addition of damping cups on the spring return end. The valve has full-feathering on both open-center and cylinder ports with minimum pressure drop at full rated flow through the valve to all portings.

Other features are: single acting spools may be furnished to push in or pull out to raise; the valve has a load check with a hardened seat to eliminate back flow to the pump and dead spots; the valve has a differential type relief valve with a minimum build-up; and it has a built-in carryover for piping from one valve to another without pressurizing seals.

The valve is adaptable to existing models of mobile equipment and is easy to install and maintain. Applications include any equipment in the construction, agricultural, industrial lift truck and commercial truck fields.





The Parker Appliance Co., 17325 *Euclid Ave., Cleveland* 12, *Ohio*

HYDRAULIC RELIEF VALVES that are pilot operated are available in four sizes from ¼ to ¾ in. for operation over a temperature range from —65 to +160 F with less than 10 percent change in operating characteristics. It has range of pressure setting from 350 to 5,000 psi which is obtained by the use of three interchangeable spring sets. The valve allows replacement of all working parts by the substitution of a new cartridge. This is done without breaking any of the lines. Pantex Mfg. Corp., Pawtucket, Rhode Island.

A NEW LOCK NUT with free spinning characteristics rides over corrosion products deposited on threads of bolts and screws, thus eliminating galling and seizure problems experienced in high temperature applications. The 1700 G series is used where temperatures reach 1,200 F; the 1700 F series withstands temperatures up to 1,600 F. Sizes: 10-32 NF-3 through ⅜-24 NF-3. They meet specification MIL-S-5059 and AN-S-126. Other self-locking types are available. Nutt-Shel Co., Inc., 811 Airway, Glendale, Calif.

USING A STANDARD DESIGN PERMANENT MAGNET MOTOR as a drive, a new blower assembly supplies 24 cfm free air delivery with a two blade propeller-type fan either by blowing or suction. Built to meet military requirements, this new magnet motor can also be supplied with a radio interference filter. The motor itself operates at 6—115 v d-c, at 10,000-13,000 revolutions per minute. Current consumption is in the order of 0.500 amperes. The Pioneer Electric & Research Corp., Forest Park, Illinois.

CONTINUED ON PAGE 234

WATER

WHEN AND WHERE REQUIRED FOR THE SUPER CONSTELLATION

PASSENGERS aboard Lockheed's luxurious Super Constellation naturally *expect* a dependable and ample supply of clean water. Thanks to Lear-Romec's efficient turbine water pumps, they get it. And along with these niceties for passengers, comes a break for maintenance personnel. Utilizing pressure feed instead of gravity, tanks are installed below the floorboard, making for simple servicing. The compact pump mounts vertically on the under side of the water tank, with all plumbing and electrical connections exposed for easy access.

The Lear-Romec pump illustrated is a submerged turbine-type water utility pump. It is one of a series available in AC and DC motor drive, originally developed for military aircraft, and produced by Lear-Romec for the past ten years. Weighs 2.8 pounds less than equivalent model vane-type pumps. Similar turbine type pumps are also furnished by Lear-Romec for aircraft engine water injection systems.

Bring your pump problems to Lear-Romec—*specialists* in aircraft fluid system components.

LEAR INC. LEAR-ROMEC DIVISION
ABBE ROAD, ELYRIA, OHIO
Executive Offices: 3171 S. Bundy Drive, Los Angeles 34, Calif.

LEAR-ROMEC MODEL RR-9700-A A fully submerged type turbine aircraft pump. Supplies wash water or anti-detonant solution. Nominal rating 110 gph at 35 psi discharge. Adjustable in range to 25 psi at 150 gph. This unit is 27 volt DC, 11 amps. continuous duty, and has integral radio noise filter on the motor. Weight 5.68 lbs.

RO-4

Direct-Operating Sequence Valve

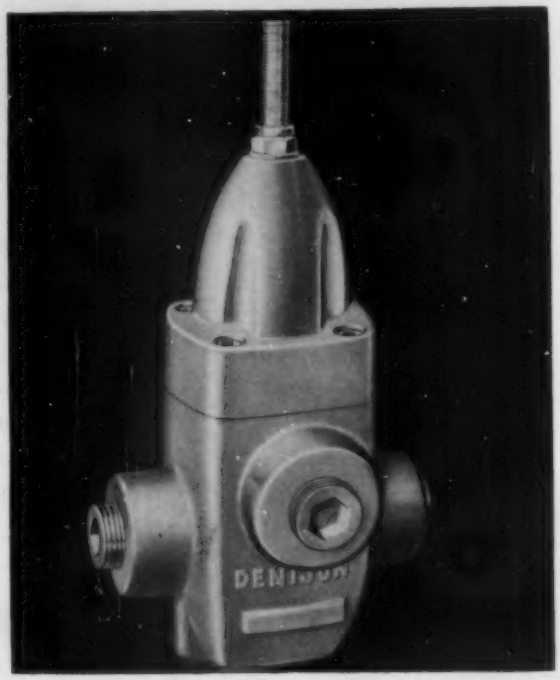
A line of direct-operating controls includes a complete line of direct-operating sequence valves suitable for operation in circuits from 25 to 2,000 psi. This valve will give precision control for inter-locked hydraulic operations, insuring close synchronization for primary and secondary operations. The pressure setting of the valve is easily adjusted. When the system pressure reaches the pressure setting of the valve, the valve will then divert oil to the secondary circuit.

Pressure build-up in the system brings quick action to the pilot piston in the secondary circuit, which may be adjusted to shift at any pressure from 25 to 2,000 psi. The use of the small pilot piston eliminates need for heavy spring loading at high pressures. The response is positive and control is close. The secondary operation begins immediately when the pressure reaches the presetting of the valve. These valves are externally drained direct to the tank.

For example, in a typical circuit using a fixed stroke pump, in which pressure is being applied to a cylinder or ram, the sequence would provide positive synchronization for a secondary operation, such as a fluid motor which must operate in precise timing with the ram.

These direct operating sequence valves designed for operation in the 25 to 125 psi and 75 to 250 psi ranges do not utilize the pilot piston. The pilot pressure is directed against the large area of the spool. This results in sensitivity to pressure changes in the low pressure ranges. Any number of valves may be used in the system, either in series or parallel, permitting precise control of several sequencial operations being performed simultaneously or in proper sequence with one another. The valves are easily adaptable to a variety of remote control operations by rearrangement of pipe plugs.

The direct operating sequence valves are supplied in threaded body styles in $\frac{1}{2}$, $\frac{3}{4}$ and $1\frac{1}{4}$ in. sizes. Subplate type is available in $\frac{3}{4}$ and $1\frac{1}{4}$ in., and the flange body is supplied in the $1\frac{1}{2}$ in. size. Pressure ranges are 25-125 psi, 75-250 psi, 125-500 psi, 250-1,000 psi and 1,000-2,000 psi. Half-inch sizes have a 15 gpm capacity; $\frac{3}{4}$ in. handles 20 gpm; $1\frac{1}{4}$ in. 65 gpm; and $1\frac{1}{2}$ in. 80 gpm.



The Denison Engineering Co., 1160 Dublin Rd., Columbus 16, Ohio

Small Hydraulic Valve Handles High Pressures

This compact, miniature hydraulic valve unit, which can be utilized as a two or three way valve in either the normally open or closed positions, will find its principal application in the automatic operation of single and double-acting hydraulic cylinders, or for pilot control of large three and four way hydraulic valves. It is capable of handling hydraulic fluids at pressures up to 1,000 psi.

All the internal parts of the V10-1000 valve are stainless steel; the slide mechanism has a precision-ground piston and a bore held to close tolerances.

Additional specifications are $\frac{1}{8}$ in. NPT threaded ports, effective orifice diameter of $\frac{3}{32}$ in., and availability for the full range of a-c and d-c voltages. Measurements are $3\frac{7}{16}$ in. high and $1\frac{3}{8}$ in. in diameter. Weight is $1\frac{1}{2}$ pounds.

Because this miniature hydraulic V10-1000 valve is of economical design and small size, it may be installed in situations where remote control devices have been considered impractical; automatic control of implements used in conjunction with tractors, and other farm equipment.

Skinner Chuck Co., Electric Valve Div., Norwalk, Conn.

CONTINUED ON PAGE 236

HIGH PRESSURE HYDRAULIC CYLINDERS

HARD CHROME PLATED PISTON RODS
Prevent Scratch-Damage, Nicks, and Rust

SOLID STEEL HEADS, CAPS and MOUNTINGS
Eliminate Breakage

DIRT WIPER SEALS
Protect Rods, Seals, Bushings

Standard Leather Cup Seal Assembly Shown Is Interchangeable With Miller Standard Piston Ring Piston Assembly

"Stock" Models For Immediate Delivery Added To Famous "Custom-Built" Line

"Custom-Built" Cylinders are available on normal delivery in an *almost infinite selection.*
Identical-quality "Stock" Cylinders are available for *immediate delivery* in these popular sizes . . .

NON-CUSHIONED: 1½", 2½" and 4" bore sizes each available in 2", 4", 6", 8", and 11" strokes. CUSHIONED BOTH ENDS: 2" and 3¼" bore sizes each available in 3", 5", 7", 9", and 13" strokes.

"Stock" Cylinders are base Model H53 with foot, flange and pivot mounting attachments available as desired.

NOTE: "Stock" Miller Air Cylinders also available!

Write For Complete "Stock" List

WRITE FOR CYLINDER BULLETINS H-104 and A-105

Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

MET J. I. C. HYDRAULIC STANDARDS years before their adoption in 1949.

SPACE-SAVING SQUARE DESIGN originated by Miller in 1945.

SALES AND SERVICE FROM COAST TO COAST

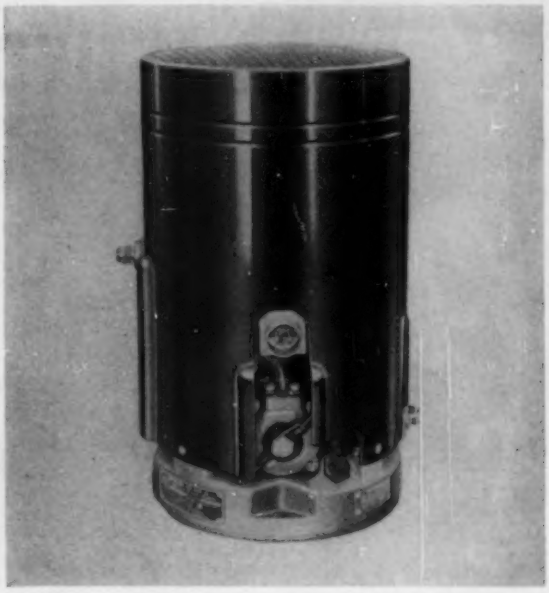
CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

MILLER MOTOR COMPANY

2002-04 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

Small, Compact Air Compressor Unit For Aircraft



A new high-pressure d-c driven air compressor, which provides a complete self-contained air source for aircraft pneumatic systems, meets Navy specifications, and is adaptable to either d-c, a-c, or hydraulic drive.

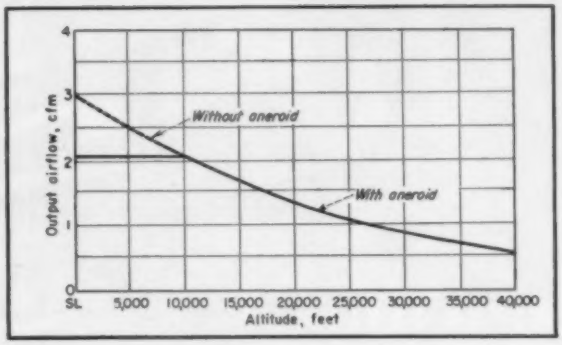
An integral package unit, containing all accessories and controls, it offers time saving in maintenance and upkeep, and can be installed or removed from aircraft in less than five minutes. Capacity of the hydraulic model is 3 cfm at 3,000 psi. Weight is 23 pounds, and the complete package will fit into a space of 10 inches diameter by 13 inches height.

The compressor features a cross-yoke construction between two sets of opposing cylinders, eliminating two connecting rods for the four pistons and effecting a saving in height, weight and friction load. Included is a planetary reduction gear designed for use between the drive motor and compressor which permits further height and weight reduction.

Piston length to stroke ratio is held to the minimum, consistent with proper spacing of the piston rings. This smaller ratio permits the use of shorter length cylinders and can be used without causing excessive wear, since the cross-yoke design creates an equivalent piston length equal to the length of the entire yoke assembly.

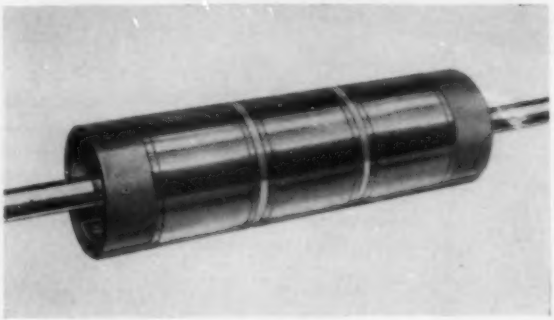
To minimize space requirements, metal-to-metal seals are used between the cylinder and valve plate and the cylinder head in all four stages. The inlet and exhaust valves in all stages also have metal-to-metal seals, a design which has proved compact and reliable.

Production at present is limited to the d-c motor drive unit, with a-c and hydraulic drives soon to be released.



Rhodes Lewis Co., 6153 W. 98th St., Los Angeles, Calif.

Stronger Permanent Magnetic Pulley



The smallest diameter available, a new four-inch diameter permanent magnetic pulley which is said to test as strong as units twice its size, utilizes a peripheral magnetic field, running completely around the pulley surface parallel and circumferentially to the shaft. The new 4 in. pulley is said to be particularly applicable as a magnetic separator for conveying systems where belt thicknesses are $\frac{1}{8}$ in. or less and speeds do not exceed 30 rpm, and is also suited as a sheet steel feeder or controlling roll. The pulley is built in 4, 8, 10, 12, 14, 16, 18, 20 and 24 in. belt widths.

Because of the proximity of the magnet castings and pole plates to the shaft, all pulleys are furnished with heavy, non-magnetic, one-inch stainless steel shafts.

Standard construction is a flat-face pulley. When a crown is required, a strip of aluminum can be wrapped around the center of the pulley to control the belt.

Eriez Mfg. Co., 7 E. 12th St., Erie, Pa.

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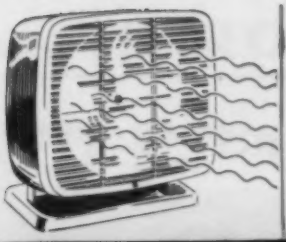


They needed a plastic that was light weight, attractively finished and dimensionally stable.

Molder, Prolon Plastics, Florence, Mass.

KOPPERS POLYSTYRENES

Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	High Impact, Lowest Water Absorption Rate
MC-301	High Impact, Improved Heat Distortion Temperature
MC-305	High Impact, Easy Flow
MC-309	High Impact, Highest Heat Distortion
MC-401	Medium Impact, Improved Heat Distortion Temperature
MC-405	Medium Impact, Easy Flow
MC-409	Medium Impact, Highest Heat Distortion Temperature

HERE is a G.E. All-Purpose Portable Fan, winner of the Home Safety, Home Fashion and Industrial Design Awards. The plastic housing is light weight, attractively colored and smoothly finished for easy cleaning. And because of its dimensional stability, Koppers Polystyrene 31 permits an exact fit of the housing and grill.

Whatever your plastic requirements you can depend on Koppers Polystyrene. Koppers makes ten types of polystyrenes, each one for a specific job. If you would like to get qualified engineering advice about the specific Koppers Polystyrene that will help make your product better and help you lower your production costs, call or write your nearest Koppers Office.

Color requirements?

Koppers booklet "Color in Plastics" shows how the science of color engineering is used in the manufacture of Koppers Polystyrenes. Write for your free copy today.

Guaranteed by Good Housekeeping

KOPPERS

Koppers Plastics

Koppers Plastics Make Many Products Better and Many Better Products Possible.

KOPPERS COMPANY, INC., Chemical Division, Dept. PE-24, PITTSBURGH 19, PENNSYLVANIA

SALES OFFICES: NEW YORK • BOSTON • PHILADELPHIA • ATLANTA • CHICAGO • DETROIT • LOS ANGELES

Hook-on, Portable Volt-Ammeter

Combining the features of a self-latching multirange hook-on current transformer, and the simplicity of an inkless recorder, this new hook-on volt-ammeter is suitable for both indoor and outdoor applications. All three components—the current transformer, a connecting lead, and the recorder—are completely interchangeable with no sacrifice in accuracy.

Some specific uses are for checking loads or distribution lines, verifying motor loads, and in detecting overload circuits, transformers, motors, and other a-c apparatus.

According to the manufacturers, a-c can be measured and recorded on both insulated and non-insulated conductors in circuits operating at potentials up to 8,700 volts. This is accomplished by hooking the current transformer around the lines and connecting the recorder to a 120-240 v, a-c source. The procedure eliminates production-line work interruption while load surveys are made.

Featuring a self-supporting hook suitable for all conductors up to 2 in. in dia, the transformer provides current ranges from 15 to 750 amp, selected by a range-changing switch on the side of the instrument.

No auxiliary equipment is needed to measure wide-range a-c voltages, since the recorder itself measures the voltages in three ranges (0-150/300/750 v) by means of the range-changing switch. Current ranges are 15/75/150/750 amperes.

Overall accuracy of the instrument is 3 percent of full scale values, except on measurements above 625 amp on the 750 amp range where it is 4 percent. The recorder

used as a rectifier-type volt-meter has accuracy of 3 percent of full scale on all voltage ranges. Accuracies are based upon sinusoidal currents at 50-60 cycles and normal ambient temperature of 25 C. The equipment weighs 18¾ pounds.

General Electric Co., Schenectady 5, N. Y.

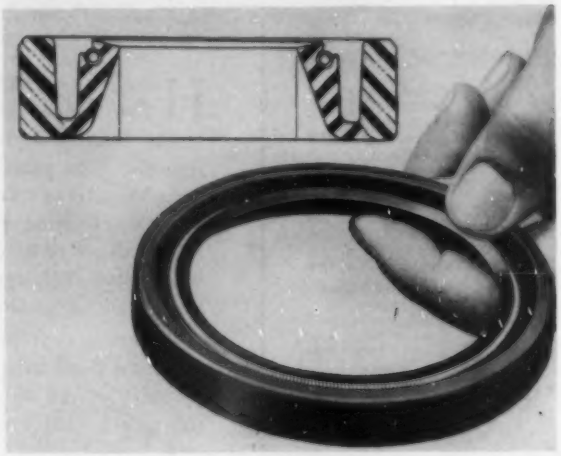
Molded Oil Seal Reduces Drag on Shaft

The LPD clipper seal, a new design in all molded oil seals, has resulted in minimum seal wear, low frictional heat, and less drag (reduced torque) on the shaft. The initials stand for line-contact proportionate design, and the line-contact refers to the lip of the seal which contacts the shaft in a thin line around the shaft circumference. The manufacturers claim that the narrow lip bearing area also reduces the need for lubrication to a minimum, yet the seal receives a greater amount of lubrication in proportion to its surface.

The proportionate design refers to the relationship between the lip area and the hinge area which stay proportionately the same throughout the range of flange widths and shaft sizes. This means that sealing characteristics are constant whether the seal size is small or large.

In this design, the lip is strong in cross section, and the hinge is proportionately sturdy. The hinge controls lip contact, and its flexibility enables the seal to adapt itself to shaft runout and minor shaft eccentricities. The lip area provides a deep retainer groove for the garter spring that further assures the sealing effectiveness of the seal. Because of this heel, the clipper seal can be removed and replaced without damage to the seal or to the cavity.

The composition heel is designed for a press fit into the bearing cavity and, since the heel is a composition material, it will conform to irregularities. Therefore, machining of the cavity to close tolerances is unnecessary. A



special reinforced heel is available where extreme vibration and shock is encountered. A variety of compositions are being offered so that the new LPD seal will be adaptable to a wide range of service conditions and temperatures.

Johns-Manville, 22 E. 40th St., New York 16, N. Y.

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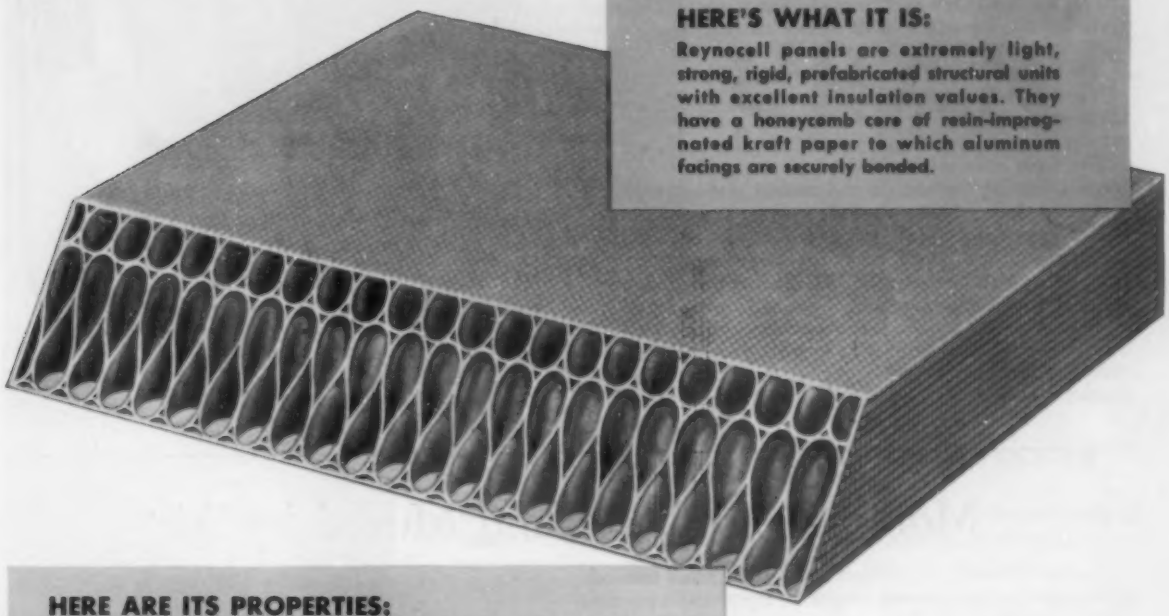
INTRODUCING

REYNOCELL†



HERE'S WHAT IT IS:

Reynocell panels are extremely light, strong, rigid, prefabricated structural units with excellent insulation values. They have a honeycomb core of resin-impregnated kraft paper to which aluminum facings are securely bonded.

HERE ARE ITS PROPERTIES:

(Typical, based on 4" thick panels. Comparably favorable properties apply to other thicknesses.)

Weight—1.46 lb/sq ft
Bending Strength—180 lb/sq ft of uniformly distributed load on 8' span
Deflection—¼" with 47 lb/sq ft of uniformly distributed load on 8' span
Crushing Strength—70 psi
Thermal Insulation (U factor)—.135
Sound Transmission Loss—31 decibels
Fire and Moisture Resistant—Fungus and Pest Proof

WHERE CAN *YOU* USE IT?

Standard Reynocell panels with .024" stucco embossed aluminum facings are available in sizes up to 4' x 16' with thicknesses from 1" to 4" and with five types of edges. Modifications are possible subject to special inquiry. Reynolds engineers are already working with a number of manufacturers on applications of this amazing new product and are available to assist your designers. Write for more complete information and specifications. Reynolds Metals Company, 2561 So. Third Street, Louisville 1, Kentucky.

†T.M. registered

See "Mister Peepers" Sundays on NBC-TV. Consult local listing for time and station.

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND

Packaged Adjustable Speed Motor Drives

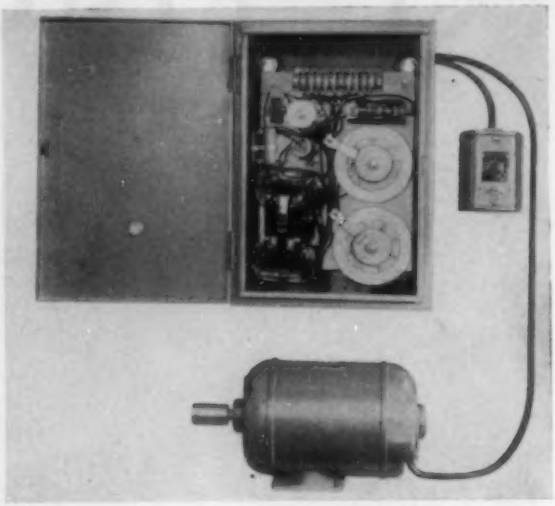
This compact, self-contained magnetic amplifier motor drive unit, which will provide adjustable motor speeds from an a-c power source, converts a-c power from a 115v 60 cycle source to d-c power which is used to drive a d-c motor. Speed is continuously adjustable over the complete range by the small rheostat located on the control station.

The standard unit will provide for a speed range of 10 to 1, and is available with motors ranging in size from 1/40 hp up to and including ½ hp.

The unit consists of three components: the main control panel, the control station and the motor. It is completely self-contained including the variable armature supply, field supply, control circuit, and overload protection.

The basic unit is provided with an on-off switch and speed adjusting rheostat on the control station. Optional features include jobbing, dynamic braking and reversing.

The device has a full wave, self saturating, magnetic amplifier unit containing no tubes or moving parts. Full wave conversion permits the use of a motor one frame size smaller than that required for half-wave units since there is less heating on full wave applications. Because there are no electronic tubes or moving parts, no warm-up period is required before applying the load, and maintenance requirements are greatly reduced.



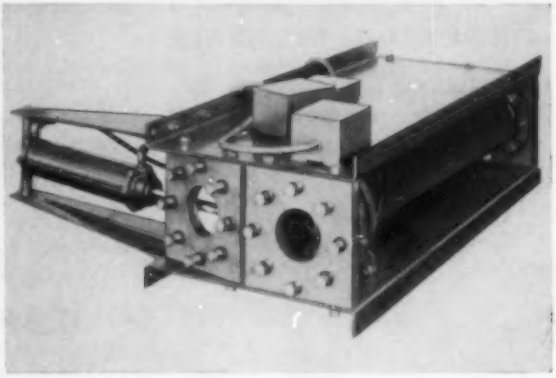
The Clark Controller Co., 1146 E. 152 St., Cleveland 10, Ohio

Molding and Core Sand Moved by Air

To take the place of conveyors, belts, and other methods of transporting sand around foundries, a pneumatic pipeline system consisting of three main components—the transporter, the pipeline, and the transfer switch—can be installed to meet any individual requirements.

The transporter is loaded with sand from the batch-mix muller, and the flap or gate at the top is closed to seal the chamber. Three inlet manifolds admit air into the transporter and twelve renewable jets distribute this air, driving the sand from the outlet cone into the pipeline.

The pipeline system transports the sand throughout the foundry or core room through four-inch pipe, in any direction, driven by compressed air. Transfer switches, like that shown in the illustration permit an unlimited number of take-off points for sand delivery to hoppers in various locations. The transfer switch permits delivery to the right, left, or straight through, and is set by pushbutton remote control. Capacity of the system is determined by the transporter, available in three sizes: 7½, 15 and 30 cu. feet.



Gerwin Industries, Inc., Whirl-Air-Flow Div., Michigan City, Ind.

REQUIRING ONLY FINGERTIP PRESSURE to join materials together, a new industrial adhesive will permanently fasten rubber, metals, wood, plastics, ceramics, or fibers together in any combination. The manufacturer claims that a force of 10,000 psi would be required to pull apart any two metals joined by the cement. The new adhesive also completely resists attack by salts, alkalis, acids, moisture or solvents. Chrysler Corp., Cycleweld Products Div., Detroit 31, Mich.

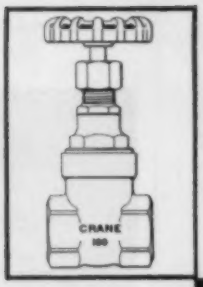
DOUBLE-ACTING CYLINDERS for air, water, or low pressure hydraulic operation are available in 1½, 2 or 3 in. bore, any stroke, and with either single ended or double ended piston rods. Features are: use of Nylined bearings; compactness; ease of assembly and disassembly; and an interchangeable assortment of foot, flange, and clevis mounts. Adjustable cushions are available front and back on the 2 and 3 in. sizes. A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.

CONTINUED ON PAGE 242

NEW* brass gate valves

by

CRANE



No. 410,
100-Pound

No. 438,
125-Pound

No. 437,
150-Pound

* NEW SHAPE... NEW STRENGTH

for 3 All-Time CRANE favorites

Here are valves that didn't have to be changed . . . because each has long been the best in its class. But Crane found ways of improvement to give you an even better buy for your brass valve dollars.

For example—here is greater strength, greater rigidity, made possible by the new cylindrical upper body . . . the same basic shape as high-pressure steel valves. Here, too, is an improved stuffing box that screws *into* the bonnet—also better stem support to assure truer alignment and minimize wear on the packing.

And not to be overlooked is their clean, modern appearance—a very desirable advantage for all of your "exposed" installations. Sizes ¼ to 3 in. Ask your Crane Representative all about this improved brass valve line next time he calls.

just off the press...
new four-page folder with complete facts including sizes, prices and dimensions. Send for yours today. Ask for Brass Valve Folder AD1944.

THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES · FITTINGS · PIPE · PLUMBING · HEATING

FACTS ABOUT ATLANTALLOY PRECISION PLASTER MOLD CASTINGS

One-piece cast ice cutter for York Corporation's Automatic Ice Maker replaced fabrication of several stainless steel parts.

Cast brush holder for General Electric aircraft generators lowered costs, provided closer tolerances and increased strength.

Lever casting of *Atlantalloy* #31 manganese bronze with tensile strength of 100,000 psi for Sargent & Greenleaf's manipulation-proof lock.

Rugged skirt door operating mechanism cast for Pennsylvania Railroad cars manufactured by the Budd Company.

• ATLANTALLOY PRECISION PLASTER MOLD CASTINGS • ATLANTALLOY PRECISION PLASTER MOLD CASTINGS • ATLANTALLOY PRECISION PLAST

Today, **ATLANTALLOY CASTINGS** are used where precise dimensions and high physical values *plus* economy are essential. These unique precision plaster mold castings can improve *your* product design and reduce *your* costs:

PRECISION — Meet precision machining tolerances. Average limits, ± .005 on one side of parting line. Minimal or no machining or finishing.

DESIGN — Compared with other techniques, this casting process makes possible the production of parts which, because of high physical properties, could not economically be produced by other means. Complicated assemblies requiring several machined parts can be cast accurately as one piece, including designs having internal teeth, stops and blind gear teeth. A wide range of *Atlantalloys* are available for your design needs. Chemical certification on request.

EXCLUSIVE CASTING FEATURES — No gas formation when metal enters mold, and no ebullition of liquid metal. Self-venting molds yield to metal, cool slowly. Castings are practically stress-free with superior grain structure. Loose cores permit "impossible" designs. Finishes are exceptionally smooth and clean.

ECONOMY — Major savings in machine work because of high finish, uniformity and accuracy. End costs below machined parts from rougher-type castings, *even for limited volume runs.* Greater savings for large runs. Time and material savings since uniform castings always fit your jigs and fixtures without rejects. Tool life extended because castings have no blow holes, hard spots, or inclusions.

SALES REPRESENTATIVES

Middle Atlantic States — Beemer Engineering Co., 401 North Broad St., Philadelphia 8, Pa.

New England — J. C. Tarbel Associates, Inc., 64 Park St., Springfield 2, Mass.

More facts on "High Quality Precision Castings for Industry". Write for your free copy!

ATLANTIC CASTING and ENGINEERING CORP.
Established 1937
810 Bloomfield Avenue • Clifton, N. J. • PRescott 9-2450

Small Motor Has High Starting Torque

Useful wherever low speed and high starting torque is required, such as aircraft actuators, remote controlled rheostats, power switches, and indexing devices, this new small electric motor can be provided with different coils for other operating voltages to operate over a wide range of frequencies as well as pulsating d-c.

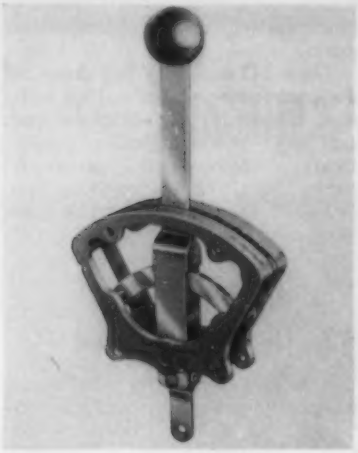
This unit has its starting torque equal to its running torque with instantaneous stopping when power is turned off. Units are now available delivering over 6 in.-lb of torque at 30 rpm, and operating over a temperature range of —60 to +500 F.

The Viking Tool & Machine Corp., 2 Main St., Belleville 9, N. J.

Vibration-Proof Automatic Locking Control

An irreversible quadrant lock control which locks automatically in any position, eliminates lost motion and has a locking action so positive that vibration or applied forces on the secondary lever have no effect, has, among its first applications, use in an aircraft gear assembly, the lock to withstand a 500 lb load.

Using the locking action between a quadrant and shoe plates under force, each shoe plate (one for each direction) has two shoes, one acting on the upper part of the quadrant, the other on the lower part. These shoe plates are pivoted with a pin, on slightly shorter radii than the quadrant, to the secondary lever. As either shoe is rotated about its pivot point, the two opposing shoes form a couple across the quadrant. The shoe plates are held in a locked position by a compression spring positioned between the two upper sections of the shoe plates. As



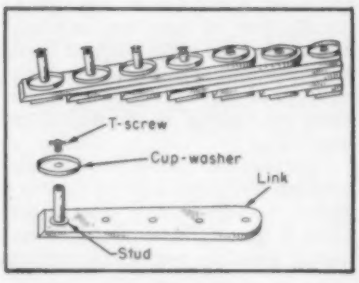
greater force is applied on the secondary lever, the couple is increased.

To automatically unlock the control, a force applied to the primary lever engages the locked shoe. And being of a shorter radius than the quadrant, this causes the opposing shoes to rapidly fall away from the quadrant in opposite directions. In a vibration test, there was no creepage, when a secondary lever load of 193-in.-lb at frequencies from zero to 3,180 cpm at a double amplitude of 0.003, 0.005 and 0.011.

Reid Metal Parts Co.,
2021 *N. Lincoln St., Burbank, Calif.*

New Type, Easily Adjustable V-Belt Drives

Known as the TD and TE, a new adjustable V-belt for D and E drives is said to be the easiest V-belt to couple and uncouple. They are made of plys of specially treated high-tensile strength canvas duck, joined by riveted studs with removable cup-washers and T-screws. This type of construction will give high strength and durability at all key points, yet permit the belts to be coupled and uncoupled easily. Two types are available: regular rubber



GLOBE PLANETARY
GEAR REDUCED MOTORS

MORE OUTPUT TORQUE
than any unit of comparable size

D.C. MOTOR and GEAR REDUCER
Produces output torques up to 2,000 ounce-inches at high gear ratio and low output shaft speeds. Length 3¾ to 3⁵⁵⁄₆₄ inches. Diameter 1¼ inches. Weight 7¼ to 12 ounces. Voltages from 6 to 100V D.C.

SHOWN ACTUAL SIZE

Globe A.C. or D.C. Planetary Gear Reduced Motors are designed for smooth performance and maximum output torque where minimum space requirements exist. They consist of a miniature Moto-Mite* motor, and a planetary gear reducer having a unique system of precision machined gears. Assemblies are mechanically interlocked, and shaft and last carrier is one integral piece for maximum reliability. Units can be furnished with standard or custom-made mounting flanges and shafts, and are available with speed governors, electromagnetic clutches, brakes, and separate or integral radio noise filters. They are designed to meet all military specifications.

Let Globe's engineers, backed by years of experience in developing custom-built miniature motors and motor products, help design and develop precision motors for your specific requirements.

Shown half-size

A.C. MOTOR and GEAR REDUCER
Hysteresis-Synchronous type motor. Voltages up to 115V A.C. Can be wound for 400 or 60 C.P.S., and can be furnished for single phase capacitor-run, or two phase operation. Length 3³³⁄₆₄ to 4²⁷⁄₆₄ inches. Diameter 1¼ inches. Weight 9¾ to 14½ ounces.

*Trademark

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Vard
Specialists
IN ROTARY-LINEAR ACTUATION FOR INDUSTRY
The VARD ball screw is an efficient, accurate and reliable mechanism. When combined with electric, hydraulic or pneumatic power units these ball screws provide the most efficient known means for transmitting rotary to linear motion.
Engineering inquiries for information concerning specific applications should be directed to the VARD sales department.
VARD INC
PASADENA 8, CALIFORNIA
CUSTOM DESIGNERS AND MANUFACTURERS OF:
BALL SCREWS
MECHANICAL DRIVES
Double Enveloping Worms
HYDRAULIC SYSTEMS
FRACTIONAL H. P. MOTORS
Electro-Mechanical Actuators

coated for general services, and oil-proof for oily and high temperature drives.

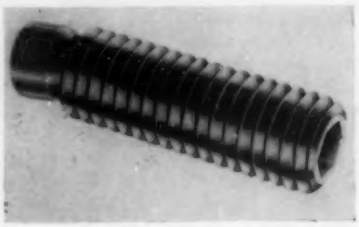
These TD and TE V-belt drives are designed for big drives and are being used successfully on equipment such as: large machine tools; presses; shears; compressors; generators; pumps; hoists; beaters; crushers; hammermills; Diesel engines; fans; and blowers.

Manheim Mfg. & Belting Co., Manheim, Pa.

Self-Aligning Rest-Pad

A new, automatically self-aligning rest-pad for clamping devices, jib and fixture work utilizes ball-bearing construction to give frictionless, automatic angle adjustment and rotation.

Called the Screw-Ball clamp it: (1) eliminates damage and marring which



occurs when an ordinary holding pad is not at 90 deg to the clamped surface; (2) automatically adjusts itself to distribute uniform pressure on work over the entire pad area at all times; (3) requires only a hex key for pressure adjustments; (4) will pass through a tapped hole from either end.

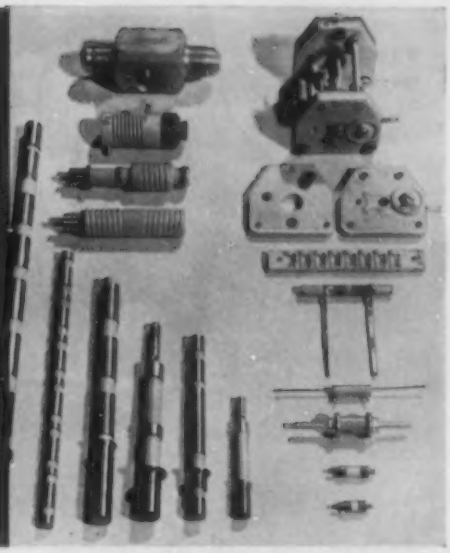
Vlier Engineering, Inc., 4552 Beverly Blvd., Los Angeles 4, Calif.

Explosion-Proof Temperature Control

The model VS control, a compact, non-indicating explosion-proof temperature control for hazardous location, is designed to maintain temperature by controlling the flow of steam, oil, gas, or electricity which heats an appliance. It may also be used to regulate the flow of a coolant, to remove heat rather than supply it, and is said to be especially suitable for controlling all types of appliances where constant visual evidence of temperature is not required.

Approved for use in the following atmospheres: Class I, group C, atmospheres containing ethyl ether vapor; Class I, group D, atmospheres containing gasoline, petroleum, naphtha,

ceramics and metal are permanently and accurately combined



The metal bands on the rotor shafts shown at the left, above, are concentric with the shaft to within 0.001 in.

Stupakoff assemblies

Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality and uniformity of Stupakoff Assemblies.

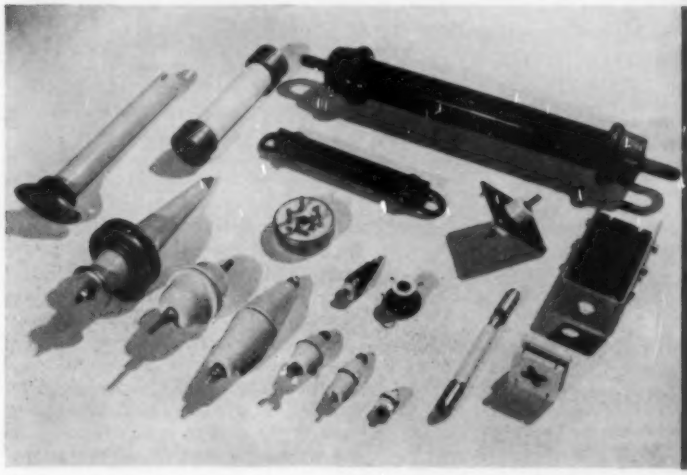
Among the assemblies made by Stupakoff are: rotor shafts, strain and spreader insulators, stand-offs and trimmers. Ceramic bodies are specially formulated for the intended service; metals used include silver, copper, brass, stainless steel and monel. Stupakoff's broad experience in this field insures the selection of a method of assembly best suited to meet service conditions.

A few types of Stupakoff Ceramic-to-Metal Assemblies are illustrated in the photographs on this page.

STUPAKOFF CERAMIC & MANUFACTURING COMPANY

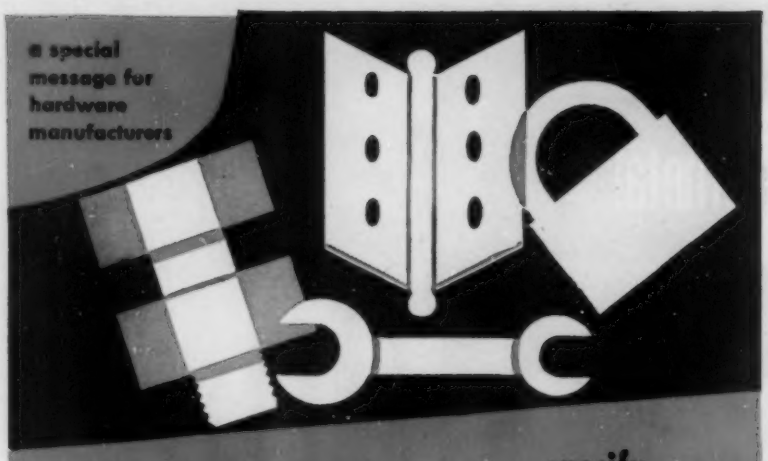
LATROBE, PENNSYLVANIA

Some of the larger types of Stupakoff metallized ceramic parts.



Small metallized ceramic parts are accurately made and dependably uniform.

a special message for hardware manufacturers



need a finish for protection—decoration—identification? specify IRIDITE®

Specify Iridite . . . for corrosion protection during storage or use . . . for a firm and lasting base for paint . . . for extra quality and eye-appeal . . . for low cost color coding of finished parts.

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
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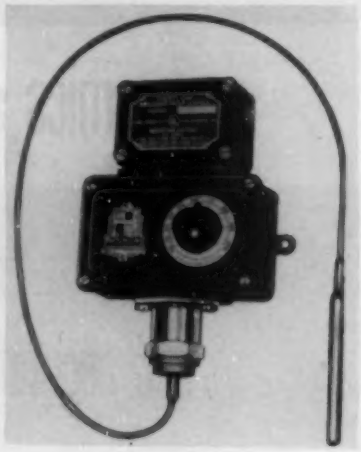
Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals, AERP Plating Chemicals.
WEST COAST LICENSEE: L. H. Butcher Co.



alcohols, acetone, lacquer solvent vapors, and natural gas; Class II, group E, atmospheres containing metal dust; Class II, group F, atmospheres containing carbon black, coal or coke dust; Class II, group G, atmospheres containing grain dust.

The maximum rating of the switch used in the model VS is 4 amp at 125 v, 2 amp at 250 v, non-inductive a-c for normal service. For pilot duty it is rated at 50 v-amp inductive load. If these ratings are to be exceeded, a suitable relay must be inserted between the load circuit and the control circuit. The control is designed for use with either two or three-wire control circuits. It is available with any of ten elements covering temperature ranges from —30 to 1,200 F.

The Partlow Corp., New Hartford, N. Y.

Sensitive, Fluid Pressure Cell

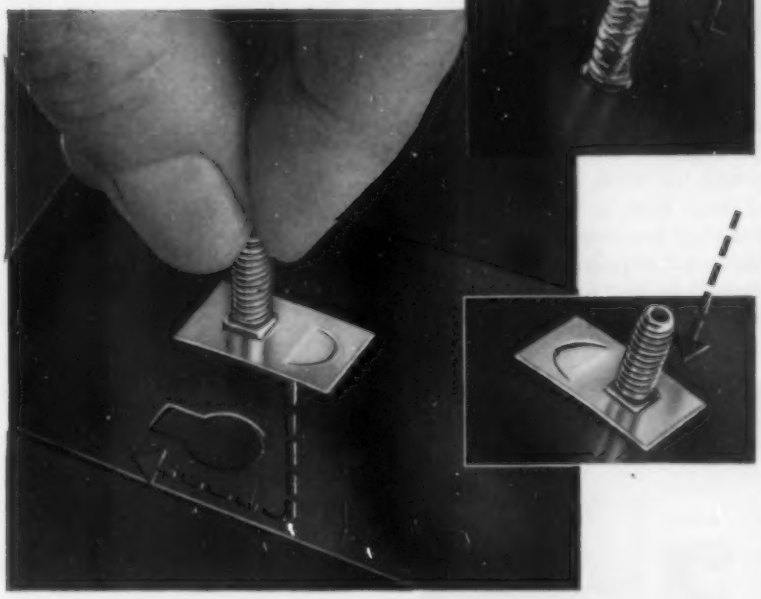
Highly sensitive, this new transducer, the Dynaformer pressure cell, converts fluid pressure into a proportional a-c voltage, which is measured in terms of pressure by an electronic resistance dynalog instrument made by this company.

The dynaformer cell consists of a bourdon pressure spring linked to a copper ring which surrounds the iron core of a differential transformer. Responding to fluid pressure, the spring positions the ring, inducing a differential voltage in the output winding proportional to the fluid pressure.

The cell is accurate to within $\pm\frac{1}{4}$ percent at any point and is protected against overrange to 150 percent of its rating. A self-contained adjustment permits the user to match the zero of the transducer to that of the instru-

NEW Quickey FASTENER

- **FACILITATES NESTING of sheet metal stampings**
- **ELIMINATES DAMAGE due to welded or staked studs**



Not this

Welded or staked studs are easily damaged in transit from one department to the next or during processing, painting, polishing, etc. The bolts themselves can cause serious damage, denting, scratching or chipping painted or polished surfaces.

But this

QUICKEY SNAPS IN just before final assembly . . . allows finished parts to be nested for economical transportation *without* protruding studs of any kind. Installed at the last moment, every Quickey is perfect. If damaged during later assembly operations, any Quickey can be removed and replaced easily and quickly, even in blind assemblies.

•

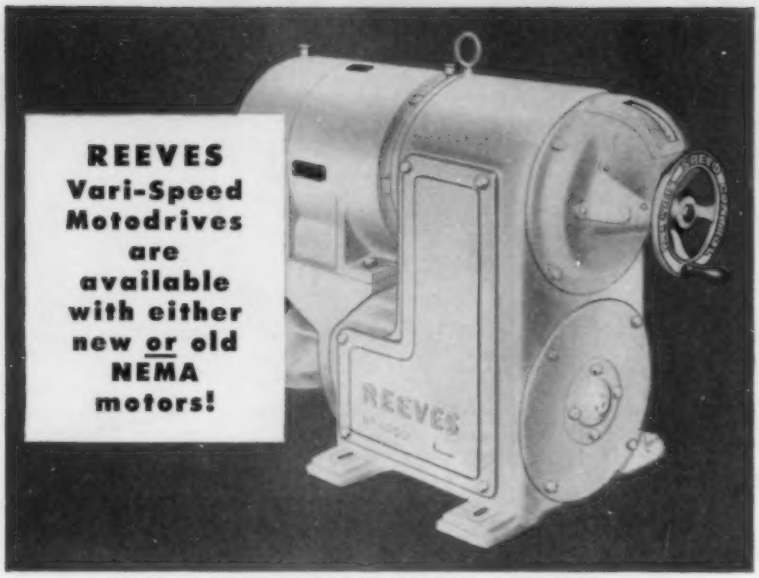
Like thousands of other fasteners and allied devices, designed and manufactured by United-Carr, Quickey helps speed assembly and cut costs. Available in a complete range of sizes and in volume quantities; further details on request.

UNITED-CARR

MAKERS OF DOT *FASTENERS*

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

Choose New or Old NEMA Motors



. . . but always choose

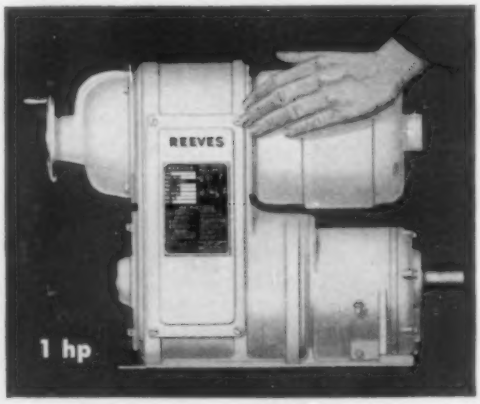
REEVES

With each new development and improvement in industrial progress—such as the new, smaller size NEMA Motors—you can always look to REEVES to be in step with the latest, most modern developments in speed control. You don't have to wait for new designs or adaptations. In keeping with their fine pioneer tradition, REEVES offers you *now* all the advantages of *smaller* Motodrives in practically every case when you order 1 hp or 2 hp drives with the new NEMA Motors. Write today for complete details to Dept. K5-3N.

Smaller MOTORS...

Smaller MOTODRIVES!

for 1 hp or 2 hp with new frame NEMA motors



REEVES PULLEY COMPANY • COLUMBUS, INDIANA

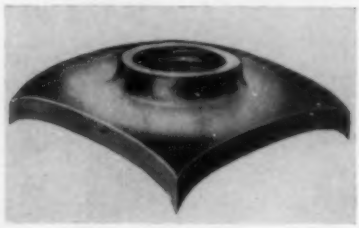
ment. Any pressure range between 0 to 30 in. Hg and 0 to 10,000 psi is available.

All parts are enclosed in a splash-proof, aluminum case with a pressure-tight cable connection. Electrical components, with the exception of an iron core of the transformer, are embedded in plastic for protection against moisture. Three mounting lugs on the case permit the cell to be mounted in any position.

The Foxboro Co., Foxboro, Mass.

Bolt Fastener Has Self-Locking Corners

The P-Nut, a spring steel, concave fastener with cut threads and self-locking corners, does not require lock washers or special assembly tools. Presently available in sizes 6-32 and 8-32, the manufacturers claim that it

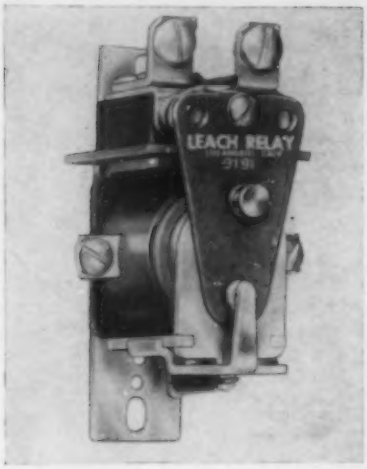


saves time and material, and can be used to fasten parts of assemblies that may be taken apart as well as those not intended to be dismantled. For the latter use, the P-Nut is deflected so that bolt threads are distorted, preventing loosening of the bolt. Other sizes of the fastener are being developed.

Waterbury Pressed Metal Co., 300 Chase Ave., Waterbury, Conn.

Heavy Duty Relay

For electrical and electronic commercial and industrial control applications a new compact, lightweight, rugged



relay capable of handling heavy contact loads with low coil power requirements, has double break contacts to provide a large gap to extinguish the arcing associated with heavy loads. Insulation and spacing meets requirements for industrial control equipment, and contact life exceeds requirements for temperature indicating and regulating equipment. Standard coils are vacuum varnish impregnated.

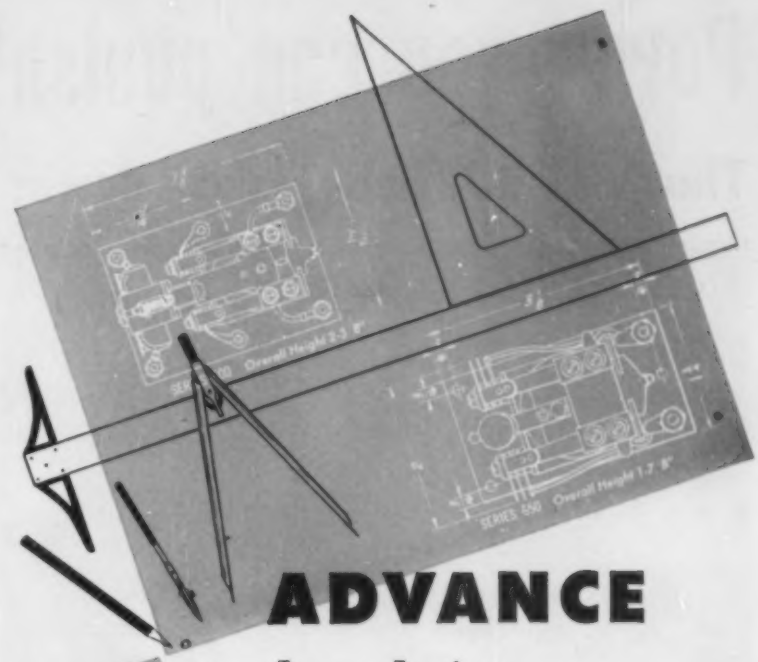
Characteristics: contacts: SPST, normally open double break; contact rating: resistive and inductive 30/20 amp, 115/230 v a-c, 1½/3 hp, 115/230 v a-c; Coil: continuous duty, a-c 8.5 v a, 60 cycle. Inrush: 14.0 v a, d-c 4.4 watts; operating voltage range: +10 percent, —15 percent a-c, +10 percent —20 percent d-c; maximum coil voltage: 600 a-c, 230 d-c; weight: 6.5 ounces.

Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.

Solenoid Valve Has Interchangeable Coil

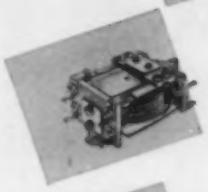
Available in three orifice sizes, and in four body styles, an improved model of the model 73 solenoid valve incorporates double-dipped, varnish-impregnated coils to assure efficient performance under extreme humidity conditions. The coil is easily changed to suit voltages required for special applications. A feature is an electrical data plate which accompanies each interchangeable coil. When a coil is changed, the new plate is fastened under the coil cover nut, identifying the data on the valve at all times. The coil cover is held with one nut, and can be rotated through 360 deg, to simplify electrical connections.

The valve is equipped with a long-life, quiet-floating plunger, and the



ADVANCE

has designs on your relay problems



Years of careful planning and study of all details of your relay requirements are built into each **Advance Relay** design. Whether your problem involves contact loads, coil resistances, close differential, timing features, input sources or critical environment, you will find an **Advance Relay** to specifically fulfill the need. For features of unusual circuit behavior, Advance Engineers can supply you with the custom, precision-built, quality relay that you require.

All **Advance Relays** meet or surpass Military and Civilian requirements. Many are AN approved. They are lightweight, compact, rugged and unsurpassed in manufacture and performance.

Write for descriptive Catalog containing detailed information on complete Advance line and Custom Engineering facilities.

ADVANCE RELAYS

ADVANCE ELECTRIC & RELAY CO.
2435 NORTH NAOMI STREET
BURBANK, CALIFORNIA

Power you can punish!

That's LE ROI heavy-duty power

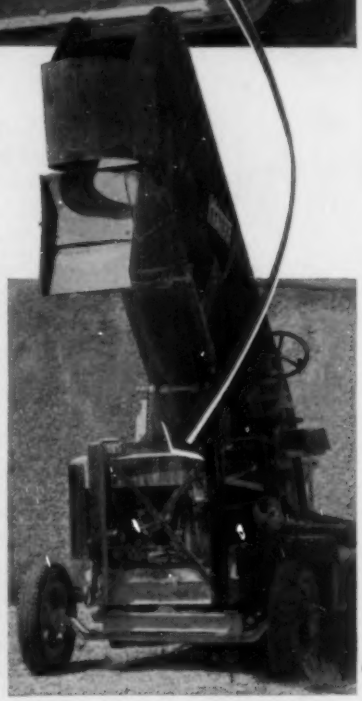
Power that pays off in
Dependable service!
Operating economy!
Easy maintenance!

THE extra reliability of Le Roi engines is a proved fact — proven by dependable and economical performance on one tough job after another.

A Le Roi is no automotive lightweight — it's a power-packed valve-in-head engine designed from scratch for *heavy-duty* service. It has the weight and stamina it takes to stand the punishment handed out to field equipment. It has advanced design, precision machining, and quick-maintenance features.

These are reasons why Le Roi is a leader in the heavy-duty field. They're reasons why you find so many Le Roi engines powering oilfield equipment, construction equipment, industrial machinery, and agricultural equipment.

Let Le Roi's performance record guide your judgment, when you buy equipment or select engines for original-equipment or replacement power. Le Roi has a full range of sizes from 15 to 635-hp — for gasoline, natural gas, butane. And remember — Le Roi power is power that pays off.

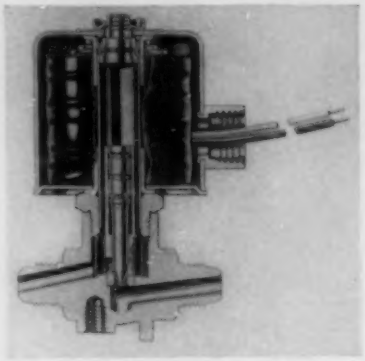


A typical Le Roi engine application in the construction field—powering a Haiss loader.

Write for latest bulletins.

LE ROI COMPANY
A Subsidiary of Westinghouse Air Brake Co.
MILWAUKEE 14, WISCONSIN
E-88

Plants: Milwaukee • Cleveland — Greenwich — Dunkirk, Ohio • Coldwater, Michigan



valve needle and seat are protected against dirt by a removable, non-corrosive screen.

Designed for use with any non-corrosive liquid and for refrigerants or air, the valve may be obtained in three orifice sizes—$\frac{5}{32}$, $\frac{5}{16}$ and $\frac{7}{32}$ and for $\frac{3}{8}$ NPT, $\frac{3}{8}$ in. flare and $\frac{3}{8}$ or $\frac{1}{2}$ in. sweat connections.

A-P Controls Corp., 2450 N. 32nd St., Milwaukee 45, Wis.

Do-It-Yourself Unit for Clutches or Brakes

For use by machine and product designers who wish to build their own clutches or brakes, this unit called the Maxitorq Disc-Pac, a self-contained unit independent of the actuator, has been introduced.

Separator springs that prevent drag, abrasion, and consequent heating in neutral, and the locking plate, which locks all disks onto the body, are the

two important features of the new design. Thus, with this unit, which keys to the shaft and is easily replaced, designers use standard maxitorq stock parts.

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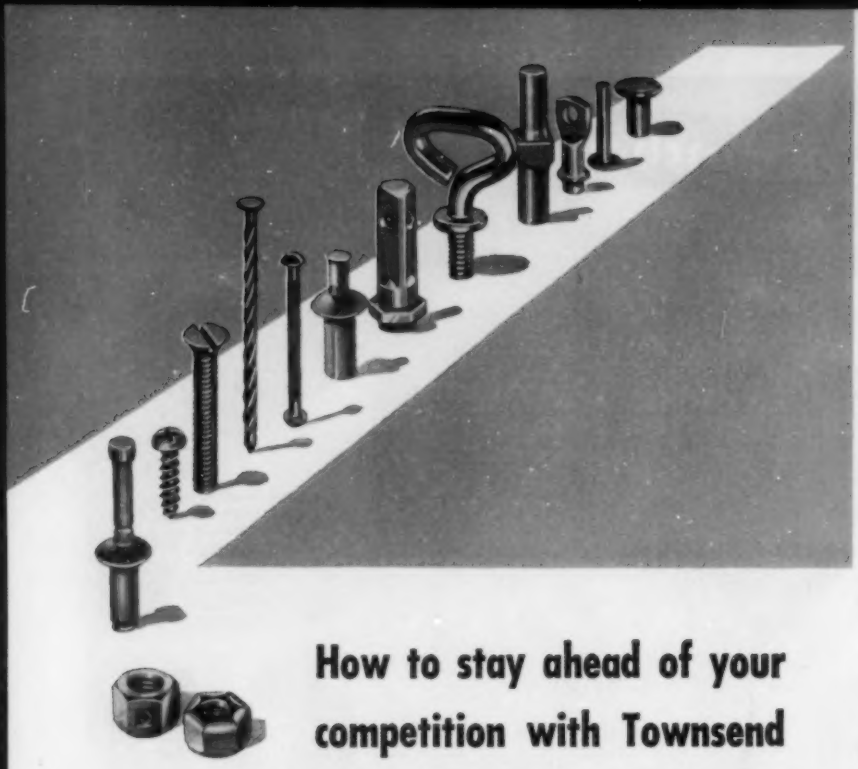

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MEETINGS

February 11-12

WESTERN COMPUTER CONFERENCE—Annual Conference and Exhibit, Ambassador Hotel, Los Angeles.

February 15-17

AMERICAN MANAGEMENT ASSOCIATION—Personnel Conference, Palmer House, Chicago, Ill.

March 2-4

SOCIETY OF AUTOMOTIVE ENGINEERS—Passenger Car, Body and Materials Meeting, Hotel Statler, Detroit.

March 4-5

AMERICAN SOCIETY FOR METALS—Mid-Winter Meeting, Hotel Statler, Boston, Mass.

March 8-11

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION—Spring Meeting, Edgewater Beach Hotel, Chicago.

March 15-19

NATIONAL ASSOCIATION OF CORROSION ENGINEERS—Conference and Exhibition, Municipal Auditorium, Kansas City, Mo.

March 17-19

PRESSED METAL INSTITUTE—Spring Technical Meeting, Hotel Carter, Cleveland, Ohio.

March 29-31

SOCIETY OF AUTOMOTIVE ENGINEERS—Production Meeting and Forum, The Drake, Chicago, Ill.

March 30-April 8

UTRECHT INTERNATIONAL TRADE FAIR—Electrical and Engineering Exhibition, Utrecht, Netherlands.

April 3-4

PACKAGING MACHINERY MANUFACTURERS INSTITUTE—Spring Meeting, Hotel Dennis, Atlantic City, N. J.

April 5-6

SOCIETY OF THE PLASTICS INDUSTRY — Annual Conference, Mount Royal Hotel, Montreal, Canada.

April 5-8

AMERICAN MANAGEMENT ASSOCIATION—National Packaging Exposition, Convention Hall, Atlantic City, N. J.

Catalogs and Bulletins

Request additional information using postcards following page 224

(1) ALUMINUM FABRICATION—Reynolds Metal Co., Booklet FP 102-3/53, 24 pp. Covers the process of fabrication from the drilling stage of the ore through the washing, melting, rolling, and final shaping. Has many illustrations showing various rollers, bending, pressing, welding, finishing and heat treating equipment used.

(2) VARIABLE TRANSFORMERS—Standard Electrical Products Co., Booklet 1053-5, 18 pp. Gives design and construction details, dimensions, and performance characteristics of the various models of auto, isolated metered variable transformers for built-in and bench applications. Illustrations show panel mountings and ganged assemblies, along with circuit diagrams.

(3) SYNCHRONOUS MOTOR CONTROL—General Electric Co., Bulletin GEA-5873, 16 pp. Their operation and control are described, along with an explanation of the areas where control is essential. Problems common to synchronous motor applications and their solution by using the correct control equipment are explained. Also has illustrations and rating and dimension data.

(4) CENTRALIZED LUBRICATION—The Farval Corp., Bulletin, 8 pp. Has complete data on several case histories of lubrication problems solved by centralized lubrication. Shows oil line diagram and the various components used.

(5) FLEXIBLE METAL TUBING—Flexonics Corp., Catalog 130R, 32 pp. Covers the full range of corrugated metal hose, convoluted hose types,

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- **Special Cold Formed Fasteners and Small Parts** explains the economy of cold-forming small parts and how to enjoy the advantages of Townsend's design service. Bulletin TL-89
- **Townsend Tapping Screws** describes seven types of tapping screws used for economical, quick, secure fastening of sheet metal, casting, forgings, plastics, plywood and composition materials. Bulletin TL-88
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- **Cherry Blind Rivets** shows how this ingenious rivet is used by one man, from one side of the work to rivet "blind" in double-surfaced structures, box sections, tubes and ducts. Bulletin TL-76
- **TWINfast Wood Screws** explains how the two threads and double thread pitch cut driving time, increase holding power in wood-to-wood, wood-to-plastics and metal-to-wood applications. Bulletin TL-67
- **Place Bolts** describes this slotted-type, one-piece, all-metal, reusable locking bolt and how it offers cost savings in vibration fastening. Bulletin TL-73.

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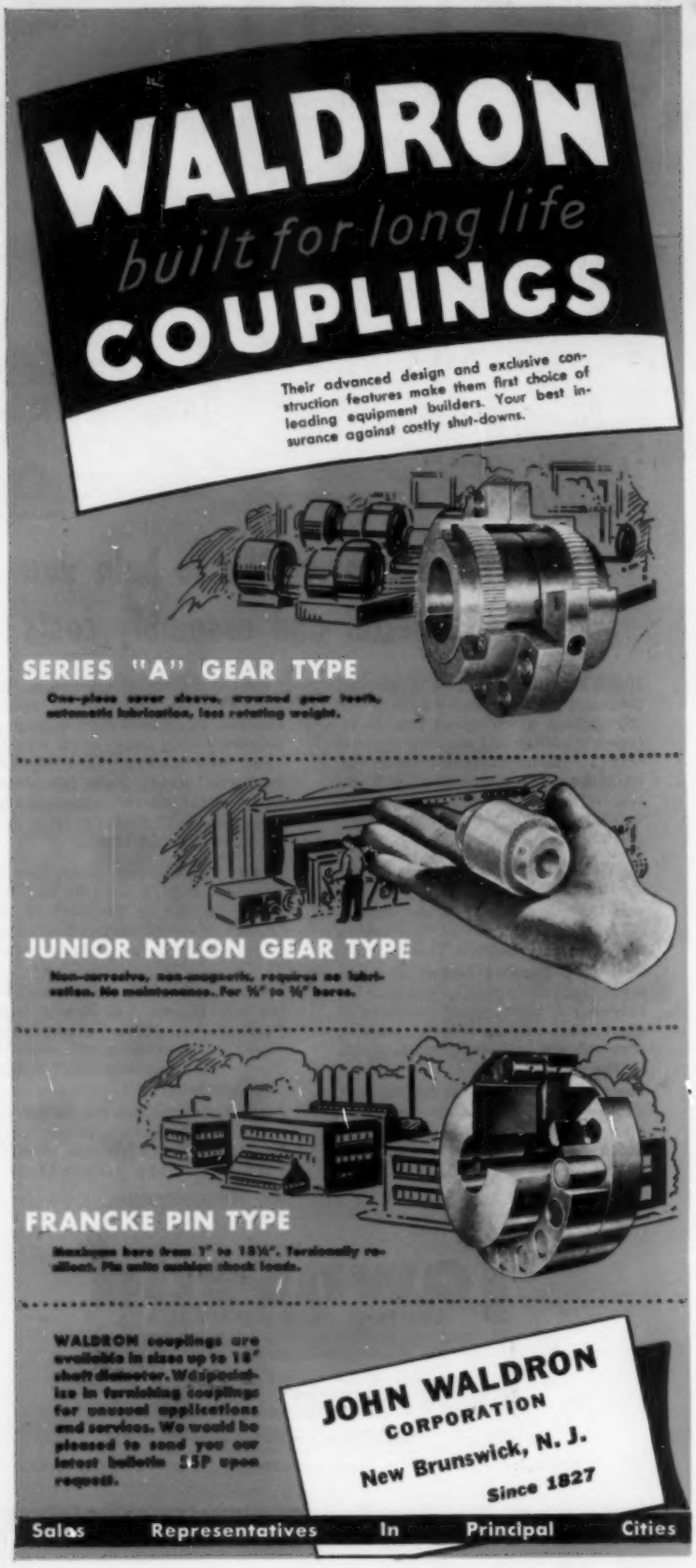
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Catalogs and Bulletins.....continued

stainless steel flexible metal hose and many special purposes assemblies. Also shown is the heavy-duty stainless steel hose, coupling types, and installation data. Has many illustrations including cross-sectional views, and specifications.

(6) HOLLOW-PLUNGER CONTROL VALVES—New York Air Brake Co., Bulletin 140, 4 pp. Explains the design and other features, along with several cross-sectional diagrams that show how staggered ports in the valve plunger provide accurate throttling. Available in capacities of 5 to 80 gpm for pressures up to 2,000 psi. Application photos and line drawings show variety of styles available.

(7) FAN ENGINEERING DATA—Hartzell Propeller Fan Co., Bulletin A-108, 16 pp. Contains much ventilation engineering information, including fan laws and formulae, terms and definitions, recommended velocities for exhaust hoods, an air pressure conversion table, and charts covering duct resistance, entrance losses and rectangular equivalents of round ducts. Has many illustrations of various fan models.

(8) ELECTRONIC ENCLOSURE SYSTEM—Elgin Metalformers Corp., Bulletin 101-CA10M-953. Shows a variety of flexible electronic console assemblies that are adaptable to all space requirements. Permits design of an assembly to individual installation requirements. Illustrations show variety of set-ups and grouping of consoles.

(9) AUTOMATIC PRODUCTION CONTROL—Reeves Pulley Co., Bulletin G-537, 24 pp. Describes not only the controls available, but also the means of solving problems involving the control of tension, acceleration and deceleration, velocity and peripheral speed, synchronization of one or more machines, and the maintaining of uniform temperature, pressure, liquid level, flow and others. Has photos, line drawings, and graphs.

(10) ELECTRO-MAGNETIC RELAYS—Potter & Brumfield Co., Brochure. Contains papers selected from those given at the 2-day Symposium on Electro-Magnetic Relays at Oklahoma

A&M College. Covers all factors connected with the design, manufacture and use of relays.

(11) PLASTIC ANCHOR BUSHING DRILL TEMPLATES—The Hi-Shear Rivet Tool Co., Bulletin, 6 pp. Falling in the "how-to-make" group, it gives complete information on laminate plastic anchor bushing drill templates, how they are made, used, and the advantages obtained. Has many diagrams and specifications.

(12) THERMOCOUPLES & ACCESSORIES—The Foxboro Co., Bulletin 235-5, 36 pp. Listed, with specifications, are standard thermocouples for all applicable temperature ranges. Separate sections are devoted to the tubular-type iron-constantan couples, wire-type iron-constantan and copper-constantan couples, and chromel-alumel alloy and platinum couples. Has dimensional drawings of complete assemblies and installation diagrams.

(13) TEMPERATURE RESPONSIVE ELEMENT—Avionic Products Engineering Corp., Data Sheet, 2 pp. Has an illustration and complete specifications for two temperature responsive elements for operation over a temperature range of −60 C to +300 C. Element consists of a beaded thermistor, features fast response.

(14) THREE-DIMENSIONAL DRAFTING—John R. Cassell Co., Inc., Catalog. The first ten pages are devoted to a technical treatise on the subject, often referred to as axonometric drawing. The remainder contains illustrations of the implements used in 3-D drawing.

(15) PLANETARY SPEED REDUCER—Philadelphia Gear Works, Catalog P-53, 16 pp. Describes this new in-line reduction unit, available in single, compound or double types and horsepower ratings in AGMA class I. Standard ratios from 4.3 to 1, up to 106 to 1. Has construction details, diagrams and selection tables.

(16) MOLDED RUBBER PRODUCTS—The Spencer Rubber Products Co., Bulletin 54-A, 8 pp. Shows products and facilities for the molding of a variety of rubber products such as pump and valve diaphragms, hose, belting, linkage, boots, tubing, gaskets,

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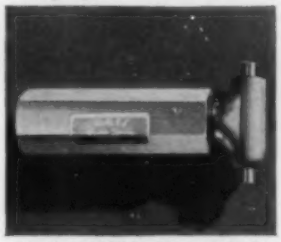

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bushings, electrical insulating parts, and others. Contains a glossary of terms and a detailed chart on how to specify rubber.

(17) PRECIOUS METALS—Baker & Co., Inc., Bulletin 4376-10-653, 36 pp. Explains how precious metals, such as platinum, palladium, iridium, rhodium, osmium, ruthenium, gold and silver, are used in various industrial fields. Has illustrations of types of products made and departments of the research foundation.

(18) BRASS & BRONZE CASTINGS—Pressco Casting & Mfg. Corp., Bulletin, 12 pp. Has data on the design, size limitations, alloys, tolerances and general information on brass and bronze pressure, gravity and centrifugal die castings. Gives all physical properties of castings made from various alloys.

(19) ELECTRIC HEATING ELEMENTS—Acra Industrial Electric Co., Bulletin, 20 pp. A guide to the proper application of heating elements when used in connection with production and industrial applications. Has complete data on clad strip and band heaters, wrap-around drum heaters, ring, cartridge, and tubular heating elements. Has a chart of specific heats of materials—solids, liquids, gases—graphs, examples of heating problems, many illustrations and other helpful data.

(20) THE AMPLIDYNE—General Electric Co., Bulletin GEA-4053B, 24 pp. Amplidyne systems, how they operate, and where they can be used are described. Includes multi-color cross-sections, circuit diagrams, charts and photos. Called "the short circuit that moves mountains," the amplidyne's electrical principles are explained step-by-step, and applications illustrated. Ratings from 2 to 25 kw.

(21) SWITCHES—Grayhill Co., Catalog, 12 pp. Has illustrations and specifications for a line of push button switches, multi-deck miniature tap switch for commercial and military use, insulators and coil forms.

(22) SURFACE FINISH CONTROL—Brush Electronics Co., Booklet, ED-21703, 8 pp. How surface finish control can reduce machinery costs, in-

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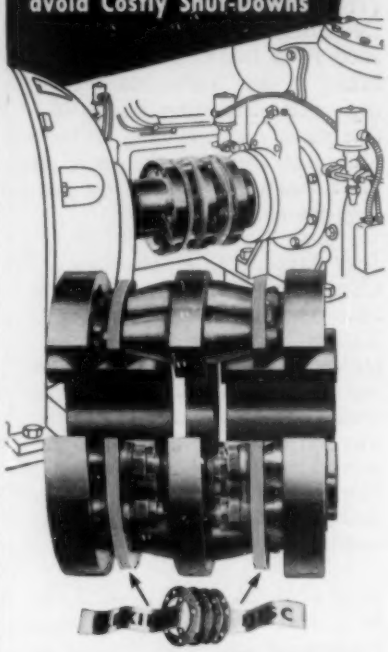

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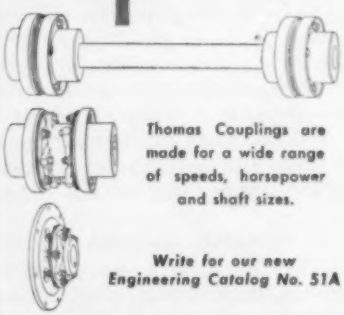

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(23) UNIVERSAL JOINTS—Gear Grinding Machine Co., Booklet, 12 pp. Covers applications, engineering data, models and sizes, proper joint selection, and other information on universal joints. Constant velocity, the principle on which the joints are designed, is described and illustrated.

(24) NEW LINE DRAWING TECHNIQUES—Eastman Kodak Co., Booklet. Techniques for converting a continuous tone image into a line drawing by means of a new photographic technique are described. The conversions, which result in an effect similar to that of a pen-and-ink drawing, may be produced from any sharply detailed good photographic film negative. All steps and details of the process are included.

(25) TEMPERATURE & PRESSURE RELIEF VALVES—A. W. Cash Valve Mfg. Corp., Booklet, 16 pp. Discusses such points as: pressure relief valves; temperature relief valves; combination types; location and installation; different types of construction; capacity and size; settings. Also includes a list of twenty-five do's and don'ts for relief valve uses. Has many illustrations and charts.

(26) ROLLER CHAIN DRIVES—Browning Mfg. Co. Bulletin CD-101-B, 12 pp. Illustrates and lists according to bore and number of teeth, a line of single fixed bore sprockets, single, double, and triple sprockets with split taper bushings, and single steel plate sprockets. Also illustrates and lists size data for a variety of roller chains, plus single, double and triple chain.

(27) HYDRO-MECHANICAL DEVICES—Pathon Mfg. Co. Bulletin 22, 32 pp. Illustrates, lists and gives complete specifications for a line of hydraulic cylinders, valves, and rams. Covers the 2,000 and 1,000 psi cylinders, and discusses construction, functional requirements, and for operation with water. Valves discussed are: pilot

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operated with or without single and double solenoid control, and spring centered or offset. Contains many line drawings, charts, and computations to determine motor size from various given data.

(28) REPRODUCTION MATERIALS—Eastman Kodak Co. Booklet F1-36, 24 pp. Information on the characteristics of reproduction materials, with new sections on projection positive paper, and microprint paper. Has data on sheet sizes, roll rizes, and packings. Contains many illustrations.

(29) METAL PROTECTIVE COATINGS—American Chemical Paint Co. Booklet, 12 pp. A quick reference guide to chemicals and processes for metal preservation. Has selection chart listing method of application, type of coating, chemical, typical metal products treated, coating time and weight range.

(30) AIR VALVES—Barber-Colman Co. Bulletin F6021, 4 pp. Describes features of a line of butterfly valves for low leakage, high temperature, and high pressure applications. Has several graphs on throttling characteristics, leakage, and static pressure drop characteristics, plus illustrations.

(31) COUNTER-AND-SWITCH UNITS—Counter & Control Corp. Bulletin 202, 34 pp. Describes the line of Cyclo-Monitors, control devices incorporating a single pole, double throw switch, and a pre-determining counter. Upon reaching the pre-set count, the switch is automatically opened or closed for a brief interval, and returns to the original position. Has many illustrations, and characteristics and specifications.

(32) CONTROL VALVES—Robertshaw-Fulton Controls Co. Catalog 200, 48 pp. Has complete data on Marotta valves, devices used for electrical (d-c) or pressure control of a variety of fluids including air, alcohol, fuel, white fuming nitric acid, liquid oxygen, hydraulic fluids, and others. Has illustrations and descriptions, plus installation drawings and flow curves.

(33) ELECTRIC HEATING UNITS —Watlow Electric Mfg. Co. Catalog, 42 pp. Has complete engineering

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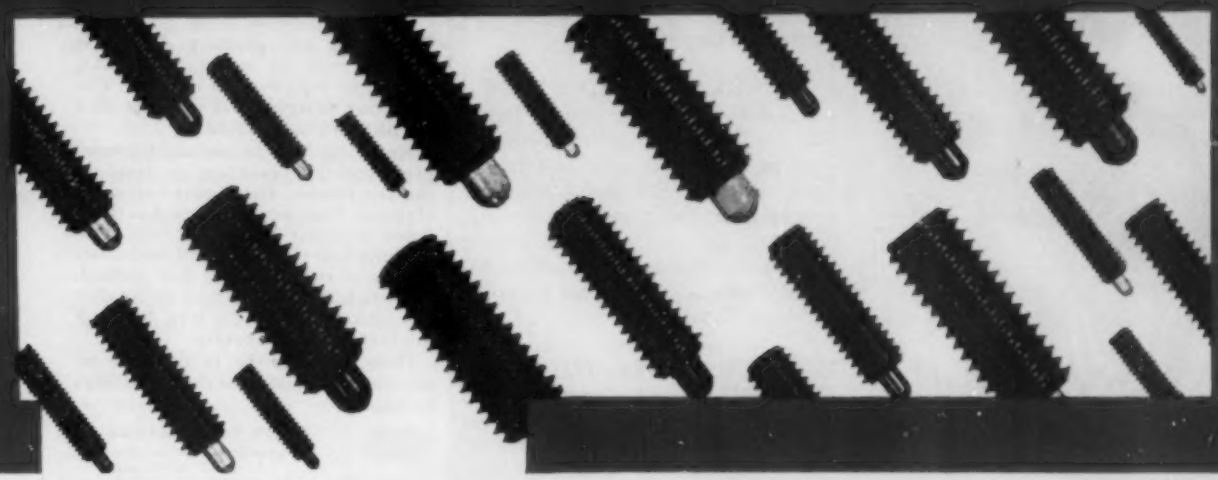
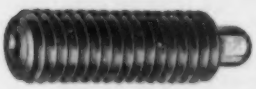
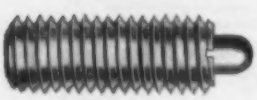


Wherever positive spring tension is required!



HEXNOSE

Hexagonal end simplifies adjustment and removal.
Standard Hex End: 4 sizes from ¼-20 to ½-13, with end pressures of 8 to 12 lbs.
Silvernose Hex: 4 sizes from ¼-20 to ½-13, with lighter end pressures of 2½ to 6 lbs.



STANDARD

Wherever positive spring tension is required . . . Facilitates fast loading and unloading of jigs and fixtures.
Standard End: 10 sizes from #6-32 to 1"-8, with end pressures of 3 to 42 lbs.
Silvernose: 7 sizes from #6-32 to ½-13, with lighter end pressures of 1 to 6 lbs.

Whether your production is routine or specialized you will find Vlier "performance proven" plungers are "uniformity assured" to do a better job. They speed set-ups, assure accurate machining and curtail unnecessary waste. When re-surfacing a die, Vlier Spring Plungers save hours of toolmakers' time.

There are 37 different types and sizes, each engineered for a specific need. Other sizes added when required.

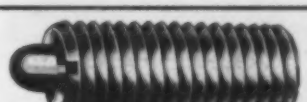
Distinctive ends (light for light pressures, dark for heavier pressures) assure positive, quick identification.

Factory pre-set end pressures provide secure contact at all times. Inset hexagonal ends allow simple, quick adjustment with standard Hex key as well as permitting full utilization of screw length for better adjustment.

Screw portions are machined from selected steel alloy, plunger is case hardened; both are rust-resistant and can last a lifetime.

An assorted stock of Spring Plungers on hand assures greatest economy for it provides your tool engineers with a selection of the proper size and end pressure for every tooling requirement.

new!



PLASTIC NOSE

Designed for work with aluminum, brass and other relatively soft, easily marred metals.
Type A (dark): 6 sizes from #8-32 to ½-13, with end pressures of 5 to 12 lbs.
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- For heavy radial loads
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data with information on how to select and apply: strip, cylindrical, ring, cartridge, tubular, and immersion type heaters. Also sections on sealing devices and hot plates, heater controls, insulators, and leads. Has wiring diagrams, recommended voltages, recommended wattages, installation, and other helpful information.

(34) AIR POWERED PUMPS—Milton Roy Co. Bulletin 1053, 16 pp. Shows how these controlled volume pumps are used to solve low-capacity flow control problems. Contains: pump operating principles, capacity-pressure and air-consumption tables, and examples of complete systems. Included are many illustrations and cross-sectional views.

(35) OIL POWER FLUID MOTORS—Sundstrand Machine Tool Co., Bulletin 113-2, 8 pp. Information on a line of oil power fluid motors for converting oil under pressure to rotary motion. With many colored cross-section views, the operating principles are described. Typical circuits are shown, and much performance data, curves and specifications are given.

(36) DIAPHRAGM MOTOR VALVES — Minneapolis-Honeywell Regulator Co. Bulletin 362, 12 pp. Describes the series 362 line of diaphragm motor valves for on-off or narrow band proportional control. Gives complete specifications for both type 26 single seated and type 27 bellows sealed valves. Has many illustrations and cross-sectional views.

(37) THIN GAGE STRIP METALS—American Silver Co. Booklet, 6 pp. Data on a variety of thin gage, close tolerance ferrous, non-ferrous, and precious strip metals. Lists thickness tolerances obtained, mill limits of metals ranging from aluminum to zirconium in both solid and composite form. Typical industrial uses of each are listed.

(38) HYDRAULIC COMPONENTS—The Hydraulic Press Mfg. Co. Set of 9 catalogs. Includes data on: pumps, motors and power units; 150 psi air or 300 psi oil hydraulic cylinders; 2,000 psi cylinders; 3,000 psi valves, flange connections; 3,000 psi valves with gasket mountings; such accessories as filters, gages, pressure

Good engineering designs depend on low cost.

SIMPLE DESIGN CHANGE TO STEEL CUTS COST FROM $1.15 TO 31¢

BEFORE any product design is accepted, the manufacturer asks, "Can it be built for less money?" Unless your designs pass this test they are likely to be rejected.

Knowing how to use welded steel gives you the advantage in developing any product for lowest cost manufacture. That's because steel is three times stronger than gray iron, two and one half times as rigid, and costs only a third as much per pound. Therefore, where stiffness or rigidity is a factor in a design, less than half the material is necessary.

Here, for example, is how one resourceful engineer put these qualities to work:

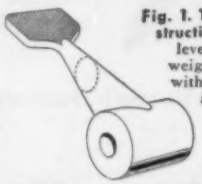

Fig. 1. Traditional Construction. Machine foot-lever, 10 inches long, weighs 6 pounds. Cost with broached keyway is $1.15.

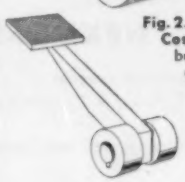

Fig. 2. Simple Steel Design Costs 41% Less. Can be built by the shop with only saw and shears. Weighs 2.7 pounds. Costs 68¢ complete with keyway.

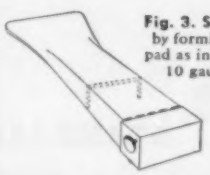

Fig. 3. Saves 53% Cost by forming lever arm and pad as integral piece from 10 gauge metal. Weighs 2.5 pounds. Costs 54¢.

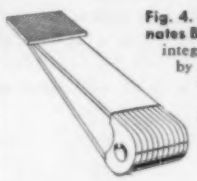

Fig. 4. Saves 73%, Eliminates Broaching. Hub with integral key is produced by stacking stampings in assembly. Arm is 10 gauge, brake formed and welded to hub. Cost is only 31¢. Weighs 2.2 pounds.

HOW TO DESIGN IN STEEL AND CUT COSTS

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switches, weld-type flanges, heat exchangers, slip-joints; another feature is the inclusion of an engineering manual on hydraulics.

(39) PLASTICS, COATINGS, RESINS—Narmco Resins & Coatings Co. Bulletins. A series of bulletins on a variety of reinforced plastics, structural foils, resins, putty, high temperature resistant laminate, metal bond adhesives, and high temperature adhesives. Has many illustrations, property listings, and application data.

(40) NICKEL CHROME CASTINGS—Standard Alloy Co., Inc. Bulletin No. 1, 4 pp. Engineering data on the HR-3 (37 percent Ni—17 percent Cr) cast alloy for use for parts subject to corrosive elements and high temperature. Gives chemical composition, physical properties, mechanical properties, heat and corrosion resistant properties, design stresses, heat treatment, and data on the alloy's machinability and weldability.

(41) STAINLESS TUBING & PIPE—The Babcock & Wilcox Co., Bulletin TDC, 8 pp. Hints on the selection of stainless tubing and pipe for corrosion resistant applications. Has many charts showing the comparative corrosion resistance of stainless steels to corrosive media, and has data on 6 widely used stainless tubing steels and includes descriptions of several hundred corrosive media at various temperatures and concentrations.

(42) MAGNETIC IMPULSE COUNTER—Kellogg Switchboard & Supply Co., Bulletin, 4 pp. Data on a new type selector switch used to solve switching or control problems where the intelligence to be registered, stored and released is supplied in the form of electrical pulses. Has typical operating characteristics, wiring diagrams and other illustrations.

(43) FERROUS CASTINGS—Belle City Malleable Iron Co., Booklet, 26 pp. Called the Ladle and Mold, it is a reference work on ferrous castings, the properties of the different types, and the methods by which they are produced. Has many tables, including a comparison of yield and tensile strengths and other physical properties. Also has many photos and photomicrographs.

THE ENGINEER RECOMMENDED TO THE PRESIDENT

"Let's invest $900..and save $4420!"

THE president approved the engineer's recommendation. A Farval centralized lubrication system was installed on a large rock crusher. Result:

Farval eliminated completely the labor of one man who formerly greased the crusher. $3,000 saved the first year! Grease consumption dropped 56%, saving another $420. There have been no bearing failures since Farval was installed. That's another $1000, previously spent on bearing replacements. And that $4420 saving is being repeated every year.

Farval is the Dualine System of Centralized Lubrication that hydraulically delivers oil or grease to each individual bearing, exactly measured, as often as desired. Today, Farval systems protect millions of industrial bearings throughout the world.

FREE LUBRICATION SURVEY—Without obligation, let us send one of our expert lubrication engineers to inspect your plant equipment and present a written analysis of what Farval can do for you. The savings possible will surprise you! Just mail the coupon or write us a note.

KEYS TO ADEQUATE LUBRICATION— Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated.

Above is shown the primary crusher referred to in the text at left, at work in a cement plant in eastern Pennsylvania. In three years since Farval was installed, this crusher has handled 1,631,331 tons of stone without one single bearing replacement.

The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.
Send Farval Bulletin 23 and details of your free lubrication survey.

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1/2"	.065"	16	.028"	22
5/8"	.065"	16	.028"	22
3/4"	.065"	16	.028"	22
7/8"	.083"	14	.028"	22
1"	.109"	12	.028"	22
1-1/8"	.109"	12	.028"	22
1-1/4"	.134"	10	.028"	22
1-3/8"	.134"	10	.028"	22
1-1/2"	.148"	9	.035"	20
1-5/8"	.148"	9	.035"	20
1-3/4"	.148"	9	.035"	20
1-7/8"	.165"	8	.035"	20
2"	.165"	8	.035"	20
2-1/4"	.180"	7	.035"	20
2-1/2"	.203"	6	.035"	20
2-3/4"	.203"	6	.049"	20
3"	.220"	5	.049"	18
3-1/4"	.220"	5	.049"	18
3-1/2"	.238"	4	.049"	18
3-3/4"	.238"	4	.049"	18
4"	.238"	4	.049"	18
4-1/4"	.250"	4	.049"	18
4-1/2"	.250"	3	.065"	16
4-3/4"	.250"	3	.083"	14
5"	.180"	3	.083"	14
5-1/2"	.180"	7	.083"	14
		7	.083"	14

*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

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Welded Tubing — Fabricated Parts

STANDARDIZE with STANDARD — It Pays

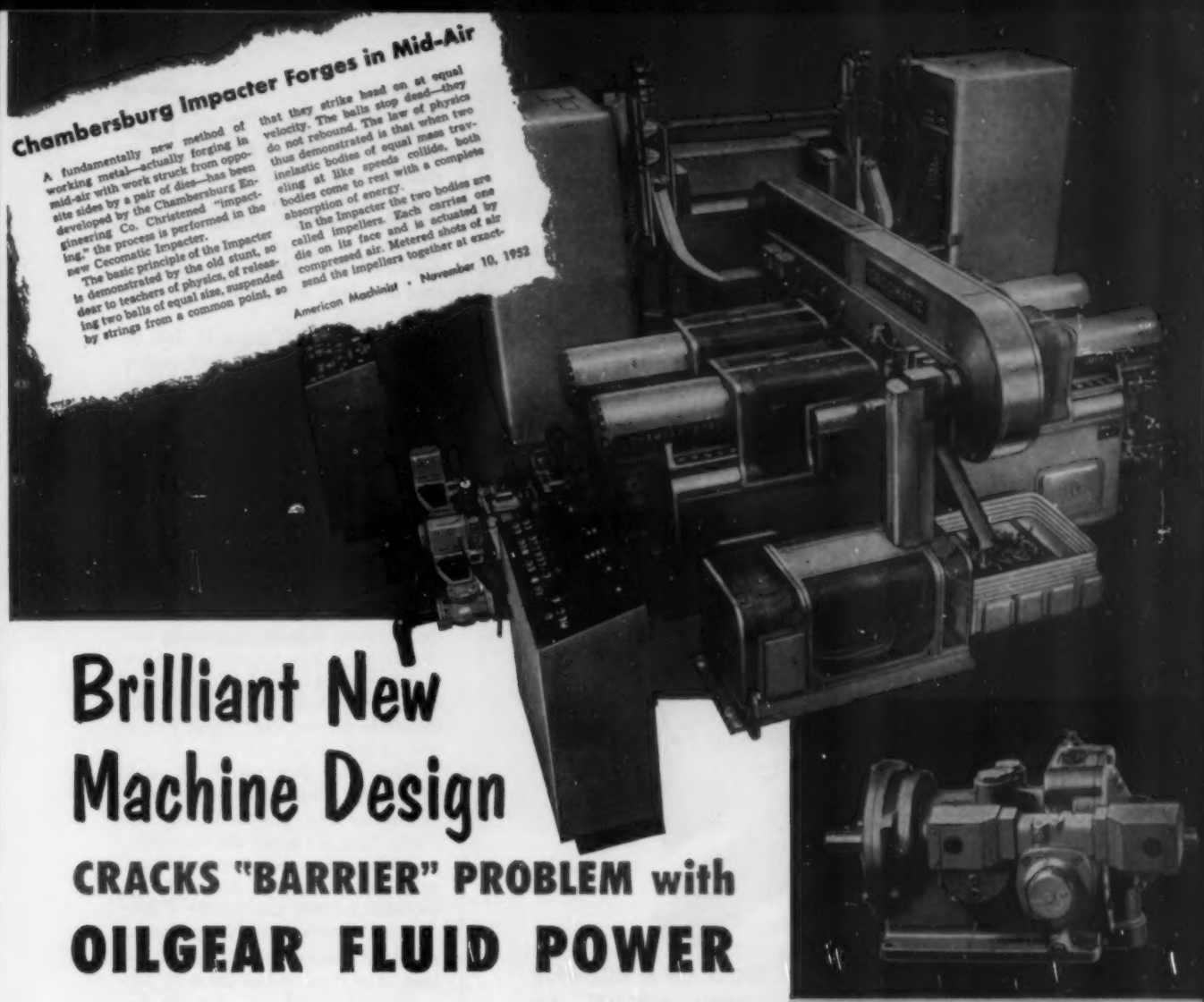
AD Libbing by the Editor

The distinguishing characteristics of philosophers, scientists and men of letters is that they approach their problems from all angles. They study both the positive and the negative aspects and investigate what is possessed and what is lacking in the theory, subject, physical object or phenomena they are evaluating. Most engineers do likewise; all of them should do so.

One of the peculiarities of the human mind is that it tends to focus its attention upon only one facet of a statement or problem. This occurs most frequently when the statement emphasizes a specific amount or a relative value. When a dairy company advertisement stated that a quart of its superb milk contained more vitamin C than a pound of sirloin steak the unthinking accepted this as being wonderful. That is what the advertising copywriter wants the people to think. The ad did not say that sirloin steak contains practically no vitamin C. Had the comparison been made with tomato juice the answer would have been different.

A recent report covering engineering activities emphasized only the negatives. For example, it stated that 25 percent of the people interviewed said "No!" which was interpreted as being definitely terrible. Simple arithmetic shows that 75 percent said "Yes!" And, because "Yes" was a favorable answer, one must conclude that the preponderant majority were on the right side of the fence. Obviously, the report writer was an extremely biased person, had made up his mind in advance, and was incapable of presenting the facts from more than one angle. His was not the mind of a scientist, and it must be admitted that many, if not most, people think the way he did.

Of course, the first reaction when the mind comes face to face with a distasteful fact is to deny its very existence. When the king of Italy was told that Galileo said that the earth



Chambersburg Impacter Forges in Mid-Air

A fundamentally new method of working metal—actually forging in mid-air with work struck from opposite sides by a pair of dies—has been developed by the Chambersburg Engineering Co. Christened "impacting," the process is performed in the new Cecomatic Impacter.

The basic principle of the Impacter is demonstrated by the old stunt, so dear to teachers of physics, of releasing two balls of equal size, suspended by strings from a common point, so that they strike head on at equal velocity. The balls stop dead—they do not rebound. The law of physics thus demonstrated is that when two inelastic bodies of equal mass traveling at like speeds collide, both bodies come to rest with a complete absorption of energy.

In the Impacter the two bodies are called impellers. Each carries one die on its face and is actuated by compressed air. Metered shots of air send the impellers together at exact-

American Machinist • November 10, 1952

Brilliant New Machine Design

CRACKS "BARRIER" PROBLEM with OILGEAR FLUID POWER

Once the "forge-it-in-mid-air" idea occurred to the Chambersburg Engineering people, there were two "barrier" problems to be smashed before the idea became a brilliant reality. Something of the seriousness of the problems is indicated by the fact they spent 10 years to get the right, precise integration of movements and forces required.

One problem, that of getting the blanks to be forged into the right place at the right time for the mid-air forging blow, was eventually solved by recourse to *Any*-Speed Oilgear Fluid Power. The standard totally enclosed Oilgear Transmission with integral electro-hydraulic control gave the designers of the Cecomatic Impacter remote, interlocked, precise control of the conveyor . . . quick, cushioned acceleration . . . high traverse speed . . . fast, cushioned deceleration . . . smooth stop and dwell in forging position; all at the speed and accuracy they needed . . . just as so often in the past Oilgear has given *other* machine designers what *they* wanted.

Maybe your problem can be solved, your machine's performance improved by the smooth, swift acceleration and deceleration of the *Any*-Speed Oilgear. Maybe you need its extreme precision of controllability . . . or any of a dozen other remarkable characteristics. In addition you get simplicity, ease of assembly into your machine, ruggedness, dependability, accessibility, a unique freedom from maintenance.

But whatever your need, *you have not exhausted all possibilities in machine design if you have not investigated Oilgear Fluid Power Pumps, Motors and Transmissions exhaustively.* You too may have a world beater in your hands. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wis.

Cecomatic Impacter doubles, triples, quadruples—octuples forging production! No jar or vibration. Less metal stress and die wear. Blanks load into conveyor automatically. And automatically the Oilgear type AXB-33 Variable Speed Transmission accelerates conveyor swiftly, smoothly, it smoothly stops with forging blank "dead on target," waits for the forging blow, then accelerates forged part away and new blank into position. Oilgear is adjustable up to 40 cycles per minute, is easily set to any required index distance which is then maintained under complete automatic control with unvarying precision.

OILGEAR

OILGEAR

Winchester Electronics

SERIES "K"

CONNECTOR RECEPTACLES FOR PRINTED CIRCUITS

3-CONTACT RECEPTACLE

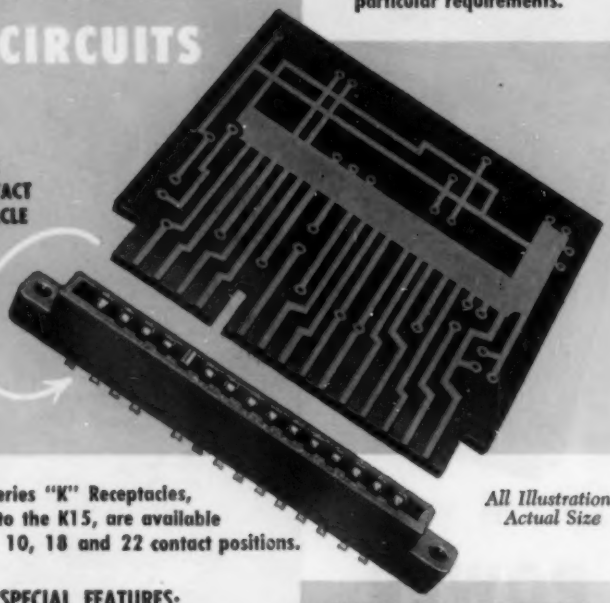
K3S

2-CONTACT RECEPTACLE

K2S

Use the K2 and K3 individually ... or together ... or in multiples to suit your particular requirements.

K15S 15-CONTACT RECEPTACLE



Other Series "K" Receptacles, similar to the K15, are available with 6, 10, 18 and 22 contact positions.

All Illustrations Actual Size

SPECIAL FEATURES:

POLARIZING pin permits engagement in correct position only. *NOTE: Polarizing pin may be substituted for any contact by indicating "dash/letter" of that position to basic code number. Example ... K15S-E 15-position receptacle contains 14 contacts (solder cup type) and one polarizing pin in position "E".*

WIPING ACTION of contacts insures positive contact at all times.

MOLDED MELAMINE bodies, mineral filled, are fungus-proof and provide mechanical strength as well as high arc and dielectric resistance. One-piece molded contsruction eliminates moisture and dust pockets.

CONTACTS are spring temper phosphor bronze, *gold plated over silver plating*, for low contact resistance and prevention of corrosion.

Winchester Products and Winchester Designs are Available Only From Winchester Electronics, Inc.

SOLDER CUP or WIRE-WRAP TERMINAL CONTACTS...For attaching #20 A.W.G. wires

Receptacles are available either with contacts having cups for soldering, or with contacts with plain terminals for wrapping lead-off wires. Add "S" to basic code number for solder cups (as K15S); add "W" to basic code number for wire-wrap contacts (as K15W).

TUBULAR TERMINAL CONTACTS also available ... for riveting receptacle to printed circuit card. Add "T" to basic code number (as K15T).

Write or phone our Sales Department for full information ... or advise your special requirements.

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rotates, he had Galileo brought before him and flogged until the scientist said that the earth stands still. As Galileo was being dragged away from the king's presence he was heard to mutter, "It moves anyhow." In other words, it is of no use to deny the existence of a fact. It remains a fact, anyhow.

Often I think of the wild days of '28 and '29. Playing the stock market was the popular sport of the day. And the higher the market went the more foolish the speculators became. I was one of the fortunate ones who did not "play the market"—for the simple reason that I did not have the stakes.

Instead of having a stake to play the market, I had a very wise counselor in Big Frank. I often wonder if I would have been smart enough to listen to Big Frank if it were not for the fact that I knew him to be uncannily shrewd and smart. He must have been to have amassed the fortune he had. Anyhow, Big Frank always forcefully derided the "stupid people who played the market."

"How can they win?" he said. "They pay 10 percent or 15 percent on the money they borrow to buy the stock. Then it's often the same company whose stock they bought that put up the margin money. And that's the way the company can declare a dividend and give back to the stockholder a little of the interest he paid on his loan. And then, because the stock pays a dividend, it goes up. And the fellow who bought it won't sell—he's too greedy and wants it to go higher.

"And George," said Big Frank, "if you have any stock, sell it. Even if you have only one share, even if you must sell at a loss, sell it. You will always be able to get it back for less."

That is why in July 1929 I owned only one share of stock. And I still have it. For purely sentimental reasons, I did not sell it. But the debt that I owe to Big Frank for that good advice he gave me is not the money he might have saved me. My debt to him is of far greater value. He demonstrated to me the workings of a coldly logical mind, a mind that entirely divorced his thinking from his emotions.

Minds that are coldly logical do not allow their thinking to be warped by their emotions. It is permissible for engineers to be emotional, but not to the extent that their emotions will dictate their conclusions. —G.F.N.

See at a glance

which Kodagraph Material will solve today's drawing reproduction problem

Free . . .

this handy wall chart lets you select immediately the Kodagraph Reproduction Material which will give you best results in reproducing any type of drawing or other original in any type of print-making equipment.

Whether you do your own print-making or order from a local blueprinter, you will find this selection chart a helpful time-saver. And a money-saver, too, for these materials do not involve complicated techniques and are surprisingly low in cost.

The chart tells you, among other things, *which* Kodagraph Materials are specifically designed to give you sharp, clean intermediate prints of old, soiled drawings; which Kodagraph Materials are best for reproducing blueprints, microfilm negatives, drawings with extremely fine detail, printed halftone pages, etc.

In addition, it gives you concise descriptions of all the materials in the versatile Kodagraph line, some of which you may not be familiar with. Also, you'll find helpful tips on processing. *It's well worth sending for today.* If you'd like more than one chart, free of charge, just say how many.

Kodak Reproduction Materials

"THE BIG NEW PLUS" in engineering drawing reproduction

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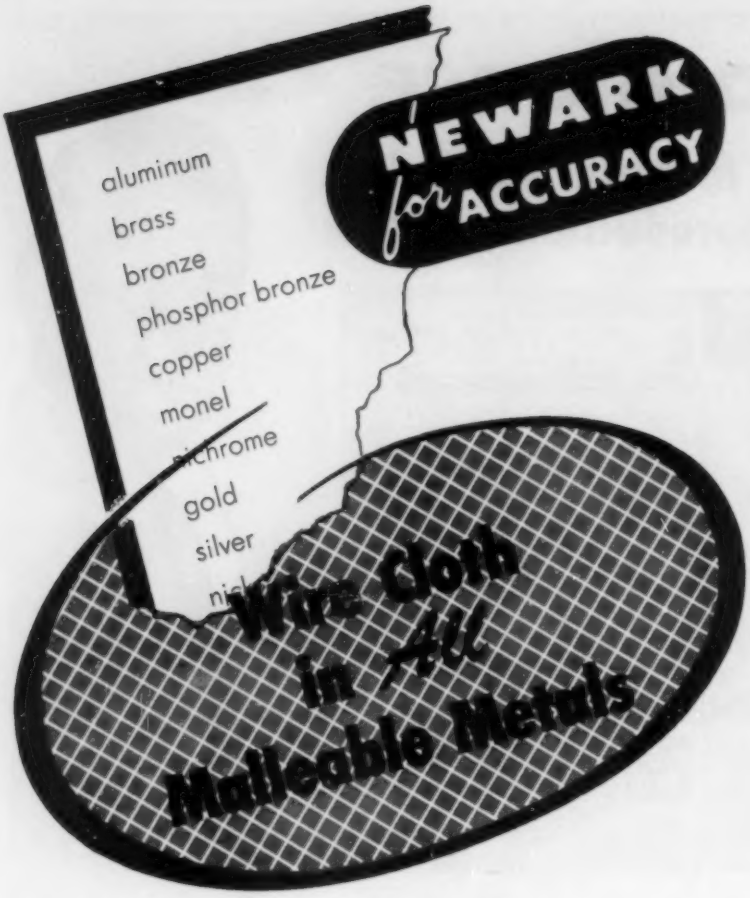

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This wide range of metals enables you to select the one wire cloth to meet your conditions of corrosion and/or contamination.

In all metals, Newark Wire Cloth is accurately woven in a wide range of meshes, ranging from very coarse (4 inch space cloth), to extremely fine (up to 400 mesh). Our reputation for 'Accuracy' through more than 75 years is your guarantee of wire cloth quality.

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ENGINEERING ABSTRACTS

Lubrication Requirements Of Gears

Abstracted from "Lubrication Requirements of Gears As Seen by a Gear Engineer," by L. J. Collins, General Electric Co., Gear Engrg. Dpt., Riverworks, Lynn, Mass. Published in *"Lubrication Engineering,"* October 1953.

SOME OF THE FACTORS which could affect the lubrication of a gear train and which might lead to a mistaken conclusion that the lubricant was at fault are: (1) Accuracy of tooth spacing, (2) tooth surface finish, (3) tooth modification, and (4) sliding velocity.

Accuracy of Tooth Spacing: If the teeth on a high speed gear are not accurately spaced the tooth surfaces are subjected to dynamic loads during operation and the severity of the dynamic loads will limit the useful power which can be transmitted successfully.

Where the teeth are very accurately spaced it has been our experience that it is not necessary to modify the theoretical load capacity with velocity factors. Tests have shown that as speed is increased, the load can also be increased. By accurately spaced teeth we mean teeth that have such an accuracy of tooth to tooth spacing that the tooth to tooth error does not exceed 0.0002 inches.

Tooth Surface Finish: If the tooth surface finish is rough, it is then composed of little hills and valleys, and the mating surfaces may be likened to two files in contact. If lubricant is applied to these surfaces, these little hills may pierce the lubricating film and allow the hills of the two mating surfaces to come in contact, or the hills of one surface may fall into the valleys on the other surface.

If the viscosity of the lubricant and applied load is such that the force applied is not sufficient to pierce the oil film, the teeth will ride on the lubricant and metal to metal contact will not be experienced. As the load is increased, however, a point will be reached where the hills on one tooth will contact the hills on the other, or the hills on one tooth will fall into the valley of another and the mechanical shearing of the metal or the bending

over of the hill will result in heat being generated.

It has often been stated that if the tooth surface is too highly refined, the surfaces will not sustain a lubricating oil film. This statement should be qualified, because the speed at which the two surfaces slide with respect to each other has a great deal to do with the ability of lubricants to separate the two surfaces. For example, if a tooth surface is very highly polished, and if the sliding velocity is extremely low, it is entirely possible that the hydrodynamic film will not be established, and the conclusion drawn is that the tooth surface finish is too finely finished for the particular application. On the other hand, where the sliding velocity is extremely high, as in the case of gears operating with a pitch line velocity in the neighborhood of 30 to 50 thousand feet per minute, an extremely fine surface finish is desirable; a hydrodynamic film is established, and the teeth can be satisfactorily lubricated. Under these high velocities, in the interest of obtaining efficiency, it is desirable to have a tooth surface finish as fine as possible.

Tooth Modification: If two gears in mesh have perfect tooth spacing at no load, smooth engagement will result. If the load is applied and is steadily increased, the teeth that are sharing the load begin to deflect; this has the effect of displacing these teeth and, since the teeth in mesh are displaced, those that are entering engagement will also be displaced. What may actually happen is that the corner of a tooth strikes the mating tooth in such a manner that the oil film is scraped off. This can be eliminated by tooth modification. This modification consists of increasing the radius of curvature at the tooth tip a certain amount and down a certain depth and is, in effect, similar to the effect of the upturned end of a pair of water skis when pulled through the water at a relatively high speed. Gears that have experienced difficulty when operating at high velocity at heavy loads have been so modified that operation has been entirely satisfactory.

Sliding Velocity: Two teeth in engagement are subject to sliding between the two surfaces at all times during the engagement except at the instant when rolling takes place on the pitch line. The percentage of sliding, or the sliding velocity between the two

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surfaces is a percentage of the pitch line velocity. The maximum sliding velocity is a function of the tooth proportions. If extremely long addendum teeth are used then the sliding velocity at the tip of the tooth is high and unless the teeth are properly modified and the surface finish highly refined, burning of the tips of the teeth may result.

Some of the most common types of distress appearing on gear teeth are pitting, abrasive wear, scoring, burning and rolling.

Pitting: In general, if the speed and load are held constant, pitting will cease after a period of time and the areas in between the pits will become polished and no further pits will result. This phenomena has been described in numerous publications and is common in the gear industry on any gears that have a surface finish which is not too highly refined.

Abrasive Wear: Abrasive wear is in general caused by foreign material in the lubricating oil and has the appearance of a tooth which has been rubbed with emery cloth or sandpaper. Since the direction of sliding is radial, the abraded surface will show scratches at right angles to the axis of the tooth.

Scoring: Scoring is in general the result of small particles having become welded to the mating elements and producing scratches extending radially along the flank of the tooth. This could be caused by the high point becoming so warm that it adhered to the mating element and produced the scratch because it is trapped in between the two loaded surfaces which are moving in opposite directions.

Burning: Burning results in a discoloration of the tooth surfaces referred to previously in discussing the long addendum tooth and indicates that for some reason or another heat was generated between the two surfaces and was not carried away by the lubricating oil, or that the load was too high or that the coefficient of friction between the two surfaces was excessive.

Rolling: It has been noted that some teeth under load will form a little burr along the tip of the tooth, which indicates that the metal is being displaced from the surface. It appears that the heat was conducted away, because the teeth are not discolored indicating excessive heating. Rolling seems to be due to a plastic flow of the mate-

rial and has been observed on teeth the loading of which for all intents and purposes could be considered moderate.

Pitting, abrasive wear, and scoring and burning might be considered as lubrication failures. If pitting is encountered, and since pitting indicates points of localized stress concentration, it is highly improbable that a lubricant could be applied which would prevent pitting. Assume, for instance, that a tooth surface was so designed that if all the load were distributed across the face, the surface would be subjected to a stress of 90,000 lbs per square inch. If, however, a number of bumps were present on the tooth surfaces and the total area of these bumps was equal to ten percent of the total tooth area, then the unit pressure would be equal to 900,000 lbs per square inch on the point thus loaded and this excessive loading would result in pitting.

Low Noise Level D-c Tachometer

Abstracted from "A Commutatorless Direct-Current Tachometer" by A. R. Eckels and W. R. Peck, presented at the AIEE Summer General Meeting.

IN MANY APPLICATIONS the commutator "noise" produced by conventional tachometers presents problems. This is particularly true where it is desirable to measure speed variations which have the same frequency components as the commutator noise, and in some servo systems where commutator noise saturates the amplifiers or introduces spurious responses.

The principal elements of this low noise level tachometer are shown in Fig. 1. Rotation of the magnet mounted on the input shaft induces eddy currents in the disk, which in turn produce a torque on the disk pro-

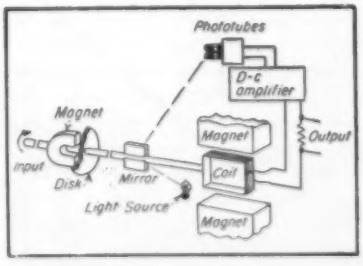

FIG. 1—Schematic diagram of low noise level commutatorless tachometer.

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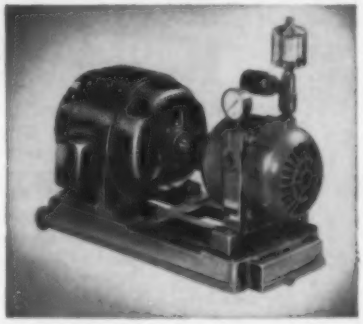

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portional to the speed of rotation. This torque will tend to move the shaft holding the disk, mirror and coil. A movement of the mirror will deflect the beam of light and cause one phototube to receive a larger proportion of the light. This will cause an unbalance between the currents of the phototubes, thereby producing a voltage signal which is then amplified. The output of the amplifier is impressed upon the coil of a D'Arsonval type instrument and a series resistance. Thus the deflection of the mirror produces a current in the coil. This current will exert a restoring torque on the coil in such a direction as to oppose the original movement of the shaft, and of such magnitude as to balance the torque produced on the disk by the rotation of the magnet. Since the current in the coil also flows through the resistance, the voltage drop across this resistance will be proportional to the speed of the input shaft.

The magnet and disk assembly exert a torque on the disk shaft which is a linear function of the input angular speed. A beam of light and phototube system is used as the shaft position detector. The maximum signal occurs for a one degree deflection of the mirror. Other standard types of position detectors can also be used.

Tests on a pilot model of this type tachometer indicate that the output signal is a linear function of the input angular velocity, Fig. 2, and that the calibration of the instrument is only dependent on the meter movement and resistor and the magnet and disk. Since these components can be easily designed for high accuracy, a highly accurate tachometer can be obtained. This particular unit was designed to be accurate within 10 rpm up to a speed of 3,000 rev per minute.

The results of tests to determine the

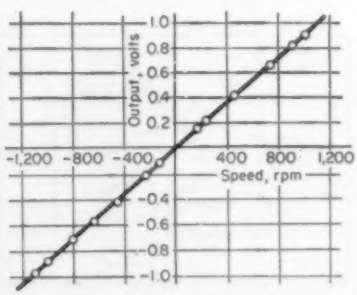

FIG. 2—Output voltage as a function of input angular velocity.

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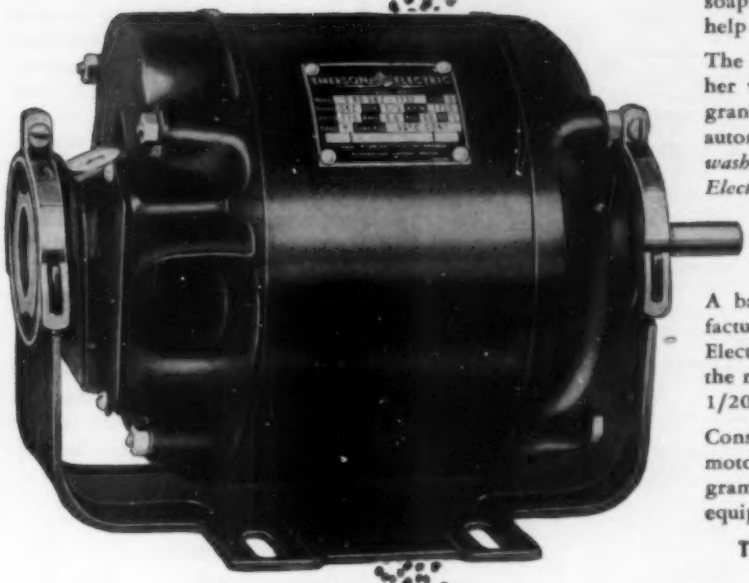

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	Protection from Corrosion	"ALODINE"
BRASS	Brightening	"ACP BRIGHT DIP"
	Cleaning	"DEOXIDINE" "DURIDINE" "ACP RIDOLINES AND RIDOSOLS"
	Cleaning for Painting	"DEOXIDINE" "CUPROTEK"
	Corrosion Prevention	"CUPROTEK"
	Soldering Flux	"FLOSOL"
COPPER, BERYLLIUM, AND COPPER ALLOYS	Brightening	"ACP BRIGHT DIP"
	Cleaning	"DEOXIDINE" "DURIDINE" "ACP RIDOLINES AND RIDOSOLS"
	Cleaning for Painting	"DEOXIDINE" "CUPROTEK"
	Coating Steel with Copper	"CUPRODINE"
	Corrosion Prevention	"CUPROTEK"
	Scale Modification	"RIDOXINE"
	Soldering Flux	"FLOSOL"
	Stripping Copper Coatings	"ACP COPPER STRIPPING SOLUTION"
GALVANIZED IRON, ZINC, AND CADMIUM	Cleaning	"DURIDINE" "ACP RIDOLINES AND RIDOSOLS"
	Corrosion Proofing	"ZINODINE"
	Paint Banding	"ZINODINE"
	Phosphate Coating, in Preparation for Painting	"LITHOFORM"
	Soldering Flux	"FLOSOL"
IRON AND STEEL	Chromate Coating, in Preparation for Painting	"CROMODINE"
	Cleaning	"ACP RIDOLINES AND RIDOSOLS"
	Cleaning for Painting	"DEOXIDINE" "DURIDINE"
	Coating with Copper	"CUPRODINE"
	Drawing and Extrusion	"GRANODRAW"
	Paint Banding	"CROMODINE" "DURIDINE" "GRANODINE" "PERMADINE" "THERMOIL-GRANODINE"
	Paint Stripping	"CAUSTIC SODA AND SOLVENT NO. 3"
	Phosphate Coating, in Preparation for Painting	"DURIDINE" "GRANODINE" "PERMADINE" "THERMOIL-GRANODINE"
	Phosphate Coating, to Protect Friction Surfaces	"THERMOIL-GRANODINE"
	Pickling with Inhibited Acids	"RODINE"
	Rust Prevention for Unpainted Iron	"PEROLINE"
	Rust Proofing	"PERMADINE" "THERMOIL-GRANODINE"
	Rust Removal—Brush, Dip, or Spray	"DEOXIDINE"
	Soldering Flux	"FLOSOL"
MAGNESIUM	Cleaning	"DURIDINE" "ACP RIDOLINES AND RIDOSOLS"
	Pickling	"RODINE (M-200)"
STAINLESS STEEL	Cleaning	"DEOXIDINE"
	Coating with Copper	"CUPRODINE"
	Pickle Polishing	"RODINE"
	Soldering Flux	"FLOSOL"

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Table I—Noise Level Comparison

Speed, rpm	Noise to Signal Ratio	
	Standard tachometer	Commutatorless tachometer
120	0.400	0.046
240	0.500	0.029
450	0.460	0.020
650	0.360	0.020
800	0.167	0.021
1,000	0.040	0.017
1,100	0.030	0.013

noise to signal ratio of the commutatorless tachometer and of a normal d-c generator tachometer are shown in Table I. The ratio for the standard tachometer is approximately ten times that of the commutatorless tachometer throughout the indicated speed range.

These tests show that this type tachometer is practical and that the frequency response can be increased by improving the mechanical construction of the disk, position detector and coil assembly. The ability of the unit to respond to high-frequency components of speed with reasonable amplifier power is also determined by the D'Arsonval movement. With a suitable meter movement a tachometer could be designed that would respond to frequency components of speed ranging from d-c to 200 cycles per second.

High-Chromium Stainless Steels

Abstracted from "Durimet 20-Carpenter 20" by Walter A. Luce, The Duriron Co., Inc., Dayton, Ohio. Published in *Chemical Engineering*, December 1953, p 276.

DURIMET 20, CARPENTER 20 and other tradename designations for composition with 20 percent Cr constitute an important part of the corrosion resistant alloy field. This highly alloyed stainless composition augments the conventional 18 percent Cr-8 percent Ni stainless steels (Alloy Casting Institute grades CF-8 and CF-8M and AISI types 304 and 316) for the more severe services and maintains at least equivalent resistance to those services for which the more conventional alloys are normally used. It bridges the gap, cost-wise and corrosion-wise, between the 18-8-SMo alloy on one hand and the Chlorimet-Hastelloy alloys on the

Table I—Nominal Chemical Composition of Cast and Wrought 20-percent Cr Steels

Element	Percent
Nickel	29.00
Chromium	20.00
Molybdenum	2.00 min
Copper	3.00 min
Silicon	1.00
Carbon	0.07 max

other. In many instances, the 20-Cr alloy is being used in conjunction with 18-8 equipment for the less severe services because its superior erosion-corrosion resistance makes it the most economical composition.

Nominal chemical composition of the cast and wrought grades is given in Table I. This composition provides an austenitic structure which makes it similar in many important respects to the conventional austenitic stainless steels (18-8 varieties).

Table II shows data for some of the more important physical and mechanical properties of the 20-Cr alloy for ready comparison. Castings in this alloy can be obtained from many of the high alloy foundries in the United States and Canada. Although each foundry has its own designation for the 20-Cr alloy, Alloy Casting Institute Grade CN-7M pertains to this analysis. Castings are supplied to equipment manufacturers who fabricate such items as pumps, valves, mixers, jets, filters, heat exchangers, fans and centrifugals.

The wrought material is available from the Carpenter Steel Co. in a va-

Table II—Mechanical and Physical Properties

	Cast	Wrought
Tensile strength, psi	65,000 min	85,000 min
Yield strength, psi	30,000 min	35,000 min
Elongation, percent in 2 in.	30–45	35–50
Hardness, Brinell	120–150	150–180
Specific gravity	8.02	8.02
Specific heat	0.12	0.12
Thermal conductivity, cgs	0.05	0.05
Thermal expansion (Mean 68 to 392 F)	8.6×10^{-6}	8.6×10^{-6}

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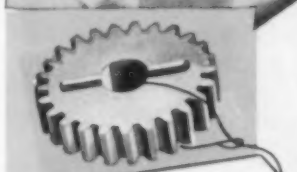

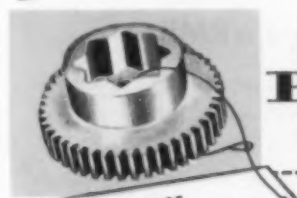

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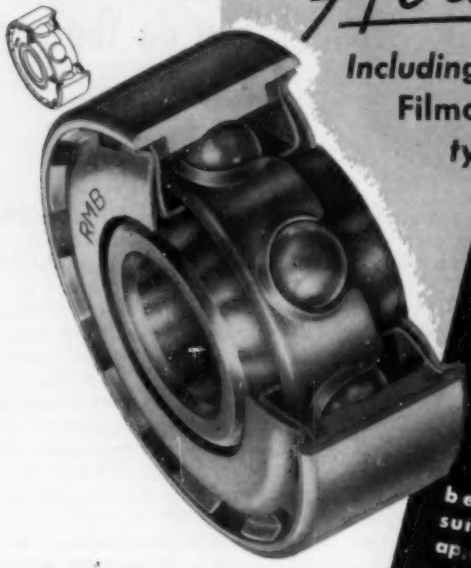

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riety of forms including, bar, wire, strip, billets, tubing, pipe, sheet and plate. Such specialty items as fastenings, wire screen, and clad plate are made from these wrought products. Most manufacturers of stainless welding electrodes include this alloy in their regular stock. Typical items in Carpenter 20 include pump shafts and seals; valve stems; agitator shafts and fastenings; nozzles; heat exchanger tubes, brackets and supports.

The machining characteristics of the 20-Cr alloy are much the same as for the 18-8 varieties. Experience gained with these other compositions can usually be applied for this alloy. Detailed information on specific machining operations can be obtained from the Duriron Co., Inc., The Carpenter Steel Co., or other producers of the 20-Cr alloy; data on forging, hot working and cold working should be obtained only from the Carpenter Steel Co. Because of its austenitic structure, the alloy cannot be hardened by thermal treatment. Cold work is the only means for increasing the hardness above the nominal value of 150 Brinell.

The welding characteristics of the alloy are considered very good. In this respect it handles much the same as the cast and wrought 18-8 grades. Although it can be welded by the metal-arc, inert-gas arc and oxyacetylene gas methods, metal-arc welding is most frequently used. As stated previously, welding electrodes in this composition are readily available. The oxyacetylene method is not usually advisable because of possible impairment of corrosion resistance by carbon pick-up. For maximum corrosion resistance in the quench-annealed (water quenched from about 2,000 F) condition the carbon content is rigidly maintained at 0.07 percent max and any increase over this value could be detrimental. In this respect the Durimet 20-Carpenter 20 alloy is similar to the 18-8 analyses.

When welding castings, it is recommended that the part be preheated to about 400 F and slowly cooled after the welding operation. Because the austenitic stainless alloys, including the 20-Cr alloy, are subject to damaging carbide precipitation during the welding operation, all castings in this alloy should be quench annealed from 2,000 F after welding. This precaution precludes the possibility of intergranular

corrosion in the weld zone when subsequently exposed to certain corrosive media.

Fabrication welding of Carpenter 20 is much the same as a comparable operation in Type 304 or 316. All wrought products are supplied from the mill in the quench-annealed condition and like castings, parts welded, forged or reheated in any manner during fabrication should be reannealed. The only exceptions to this are Carpenter 20 plate, sheet and tubing which are so processed as to allow fabrication by welding without further quench-annealing. It is important to emphasize that all cast and wrought products are given the necessary quench-annealing operation in the foundry or mill as part of the production cycle to assure maximum corrosion resistance and it is only those parts given subsequent thermal operations which require reannealing.

Extensive experience has been gained on the corrosion resistance of the Durimet 20-Carpenter 20 alloy. Although resistance to sulfuric acid has been its main advantage, the 20-Cr alloy shows superior resistance to that of the 18-8 alloys in many other services. Applications where this composition has proved vastly superior include hot acetic acid, brines, strong hot caustic solutions, hydrofluoric and hydrofluosilicic acids (dilute), strong nitric acid (fuming), nitrichydrofluoric pickling acids, hot sulfates and sulfites, sulfuric acid (all concentrations to 150 F, many to 176 F and higher), sulfurous acid, phosphoric acid and plating solutions.

Magnesium for Aircraft Structures

Abstracted from "WADC Evaluates Magnesium: Good, But—," *Aviation Week*, December 28th, 1953.

A WRIGHT AIR DEVELOPMENT CENTER EVALUATION of structural magnesium in aircraft says that its use would reduce the cost of planes and conserve aluminum, which may be a critical material in an emergency. The scope of the report concerns the technical properties of magnesium insofar as they influence the suitability of the material for large-scale use in primary structures of aircraft. Also, it considers only the facts which are important for a routine mass production

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by an adequately experienced and equipped industry.

Magnesium is evaluated from three points of view: (1) performance (physical characteristics); (2) structural safety (reliability); (3) procurability (productibility and related factors) of aircraft fabricated from magnesium.

Performance

These are the important factors under the category of performance: strength-to-weight ratio, stiffness and suitability for use of elevated temperatures resulting from high-Mach operation.

Strength-to-weight ratio of a complete magnesium structure appears to be equal, essentially, to that of a comparable aluminum structure, and this can be bettered in favorable applications. This conclusion is based on experience gained with B-36 parts, Sikorsky helicopters, Dow-built T-6 wing panels, and also with the F-80 fuselage and wings built as all-magnesium structures.

Stiffness of a magnesium structure generally will be better than that of a comparable aluminum structure. This is because the specifically lighter and weaker magnesium generally will be used in thicker cross-sections, which means that less buckling under loads will occur.

This favorable stiffness may be an important point in favor of magnesium. Efficiently designed magnesium alloy wings will have superior aerolastic properties permitting increased performance where flutter and aileron reversal are the limiting criteria. Use of magnesium may make possible the design of thinner wings.

Present temperature limits for magnesium are about the same as for aluminum, 250 to 300 F. But alloys having satisfactory properties at temperatures as high as 500 to 600 F have been introduced as castings in certain new engines. Also, in addition to those already in use, sheet and plate alloys for use at such high temperatures are ready for service testing.

It is not yet certain that these developments will be successful, so far as use in primary aircraft structures is concerned. Such problems as riveting and corrosion-protecting these high-temperature alloys may prove critical. However, the prospect is that magnesium may find its place about midway

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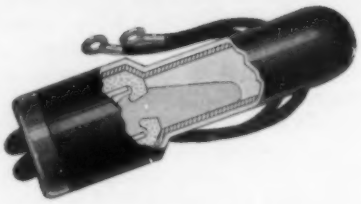

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between aluminum and titanium as a material for high-speed aircraft.

On the question of performance, superior designs can be achieved by using magnesium alloys in applications where their low specific gravity, in conjunction with other physical and mechanical properties, can be utilized to advantage.

Structural Safety

From the viewpoint of structural safety, magnesium is a material that must be used with great caution. Any deviation from the "correct" design, manufacturing and maintenance rules very often will be dangerous.

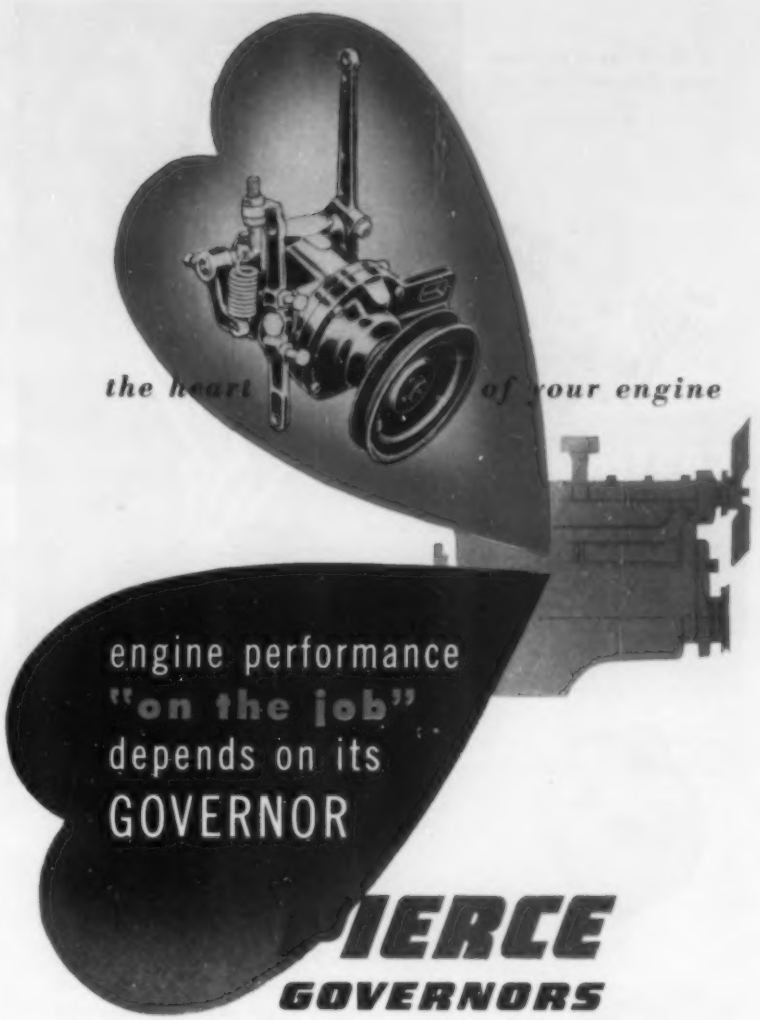
This great sensitivity to abuse is a basic property of magnesium. So, while the capability to stay safely and more easily within the limits set by the material work is improved, the properties of the material cannot be changed to any great extent.

Basically, magnesium has two properties that make it so sensitive to deviations from correct handling methods: First, although the material allows a rather normal elastic deformation, it permits only little plastic deformation where it breaks; and second, it has great sensitivity to corrosion.

The low plastic deformation expresses itself as sensitivity to local stress concentration, which makes it necessary to avoid notches, abrupt changes in cross-sections, and any design involving complicated stresses that do not permit a reliable analysis of the stress distribution. Care must be taken not only in shaping the structural elements, but also in joining them, especially when these elements have different cross-sections.

Another stress concentration factor is the material's reaction to improper riveting. When rivets are over-squeezed or over-hammered, the parts can become locally over-strained, resulting in cracks at the rivets. Also, a rivet-pattern may transmit a structural load in an uneven distribution, so that certain rivets carry more than others. This condition can occur as a consequence of misalignment of rivet holes or of deformation of parts under the rivet closing pressure. Under such an uneven load distribution, magnesium structures will fail in cases in which structures of 24S aluminum alloy would yield sufficiently to make all rivets carry their share.

Of all structural metals, magnesium



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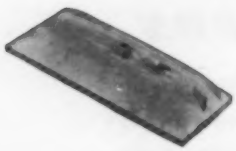

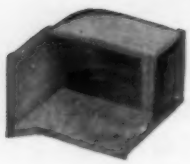

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is the most susceptible to corrosion. No method of satisfactorily protecting it by means of plating is in sight, and flawless insulating against any outside influence is the only safe protection. Corrosion of free magnesium surfaces is not critical under normal conditions, but the material corrodes rapidly in the presence of any dissimilar metal plus any liquid acting as an electrolyte.

Procurability

Procurability falls into two categories—producibility and toolability. With respect to producibility—the cost of producing the end item itself—magnesium is appreciably better than aluminum, mainly because a properly designed magnesium structure will generally consist of fewer parts than an aluminum structure. This is so because the material's stiffness properties make stringers and stiffeners largely unnecessary.

Experience with F-80 and F9F wings has shown that a properly designed magnesium wing can be built with about 60 percent fewer parts and 25 percent less manhours than a comparable aluminum wing. These figures were derived from experience with a small-scale production, relying on much skilled labor and comparatively little tooling. In true mass production, with complete tooling, riveting machines, etc., plus unskilled labor, used with both materials, a similar result might be expected.

The conclusion on costs is that one can expect an appropriately designed magnesium aircraft to be appreciably cheaper to produce than comparable designs in aluminum.

With respect to tooling, magnesium offers appreciable advantages for the procurability of prototypes and small operational quantities. For small-scale production, simple sand castings can be used instead of all or some forgings.

Advantages, though somewhat smaller, may also possibly be involved for full scale mass production. In tooling for such mass production, the extremely strict requirements for perfect workmanship would undoubtedly demand rather extensive tooling, whereas a small production can easily avoid this problem by substituting skilled labor for elaborate tooling.

Magnesium requires a great deal of hot forming, but no additional tooling cost is expected since 75S aluminum alloy also requires it.

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OUR READERS SAY

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York, 36, N. Y.

Simplifying Calculations Too

To the Editor:

In *Product Engineering* for December, page 213, "Calculator for G Loadings," the formula given is $g = 0.284 N^2R \times 10^{-4}$. This formula works all right, however, if we use $g = 0.10225 N^2R$; where N is revolutions per second and R is in inches, we have something that uses smaller numbers. More important, however, for good approximations rapidly (mental arithmetic), $g = 0.10 N^2R$. The error in the approximation or the "penalty" for using speed will be 2.25 per cent. For 10,000 rpm at one inch radius, the error would be a $63g$ low from a true value of $2852g$; at 5 inch radius, a low of $314g$ from a true of $1458g$.

Much work is being done at very high rpm's, so the above may be of interest.

The above was prompted by your editorial on speed in drafting. Why not also, where possible, a little speed in the previous calculations.

—H. A. RATCHFORD
Sylvania Electric Products, Inc.

An Acknowledgement

To the Editor:

In my article, "Silicone Putty for Slip Clutches and Couplings," which was published in the October number of *Product Engineering*, I failed—through an oversight—to give the Lord Manufacturing Co. credit for the source of the data used in the article.

When I first invented the Silicone Putty Slip Clutch and Coupling and started to work on its development, the Lord Manufacturing Company became interested in the device and agreed to conduct tests. A great deal of the data that I presented in the article are taken from tests conducted by the Lord Manufacturing Company in the course of

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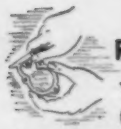

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the development of the device. I hope that *Product Engineering* will be able to make a suitable acknowledgment of this fact as I feel that the Lord Manufacturing Company should receive credit for the part they played in the development of the clutches and couplings. —MILTON ADLER

Ed—It is a pleasure to publish this acknowledgment. Only too often the pressure of circumstances prevents proper attention to the niceties that add so much. We commend Mr. Adler for making this acknowledgement and we fully understand his oversight.

An Incomplete Issue

To the Editor:

I was very disturbed upon receiving my December copy of *Product Engineering* to find that the Perspectives section was missing. I hope that this was only a printing error of some sort and that you have not dropped the section. Perspectives is an important asset of *Product Engineering*—valuable to your readers. If the section is to be discontinued, I am sure that many readers will protest.

—EMERSON SWARTZ
New York, N. Y.

Ed—We are indeed sorry. It was a production mishap; Perspectives, of course, is not being discontinued. We've sent you a copy of the pages you missed.

More on "Expensive Fancies"

To the Editor:

Your editorial, "Expensive Fancies," in the December issue of *Product Engineering*, is indeed timely. Educators are now in the process of re-evaluating engineering curricula. Engineering Drawing has received its share of re-evaluation in this process.

Dr. L. C. Grinter, Dean of the Graduate School, University of Florida, who is chairman of the ASEE committee on re-evaluation, has released a progress report that states:

"Graphical representation is both a form of communication and a tool for analysis. Its professional usefulness may be evaluated in terms of its success in these directions. Its value as a

Plain Pointers on Projection

MOST optical textbooks mention the French physicist Augustin Jean Fresnel in connection with his work in helping to establish the wave theory of light. However, Fresnel also contributed greatly to the design of optics used for lighthouses. His work in this field, which forms the basis upon which lighthouse opticians still work, has led to the coupling of his name with a distinctive "flat" lens type.

At first glance this might seem removed from the field of optical gaging and the use of contour projectors throughout industry. The truth of the matter is, however, just the opposite. In designing the Kodak Contour Projector, our optical engineers have included a Fresnel lens directly behind the instrument's ground-glass screen.

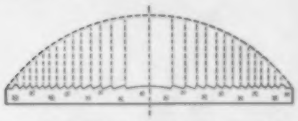

Fig. 1. Steps of the Fresnel lens duplicate the curvature of conventional condensers, making it possible to "collapse" a lens into a flat plane.

This flat plastic lens is illustrated schematically above (Fig. 1). In effect, a curved surface is collapsed into a series of minute steps which reduce the mass of the lens to a practical size. A conventional lens used for the same purpose, of diameter to equal the projector screen, would be more than 5" thick, heavy, and not inexpensive.

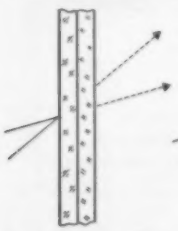

Fig. 2. Diffusing properties of ground-glass screen scatter oblique light away from viewer's eye.

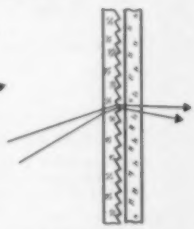

Fig. 3. Fresnel lens behind ground-glass screen directs oblique light towards viewer.

Use of the Fresnel lens in this manner serves a double purpose: 1) it effectively increases screen brilliance by directing the light on the screen directly at the operator's position; and 2) it provides even illumination over the entire screen area.

Because of this our projectors may be used under normal shop illumination without hoods or curtains—both of which sometimes tend to give a feeling of claustrophobia. In addition, the over-all screen brilliance makes possible easy reading of critical tolerances at any point on the projector screen. Together, these attributes tend to make your personnel more contented and efficient . . . help to make contour projection suited to mass inspection needs.

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At General Electric's jet engine plant at Cincinnati, Ohio, engineers have solved one such problem using Kodak Contour Projectors. Rotor blades arriving in lots of 2000 to 5000 are given a 4 per cent AQL check by the young ladies seated above. Eleven dimensions, including angles and radii, are checked on the dovetail contour, and 14 different dimensions checked on the rotor blade root—all at a rate of approximately 150 pieces per hour. Optical gaging has lightened the load, reduces inspection time, helps to keep the production line moving.

The Kodak Contour Projector is particularly suitable for such routine production inspection. It requires no hoods, curtains, or darkened room (the column at the left tells you why). Operators work rapidly and accurately in comfort—require little training. And, simply by changing chart-gages and staging fixtures, all sorts of complex parts, large and small, can be inspected.

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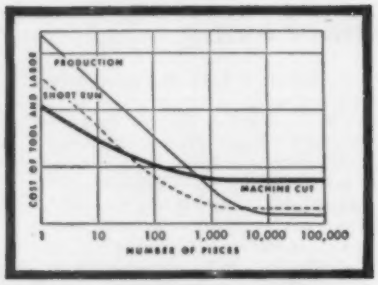

This logarithmic chart shows the effect of these factors on the **specific part** illustrated. From 1 to 65 parts, our own Machine-Cut Method with standard dies is most economical. At 65 parts, the Short-Run Method using economical blanking dies and stock punches is best until, at 7,000 units, the standard Production Method with standard dies is most satisfactory.

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skill alone does not justify its inclusion in a curriculum. The ability to convey ideas by drawing should be measured at an appropriate time and where deficient should be developed so that its use is evident in the reports presented for advanced courses. Another ability to be developed in this study is spatial visualization. Since most creative engineering work is initiated by the process of illustrating ideas by sketches, it is believed that an experience in the use of technical sketching that may be obtained in drawing offers the opportunity for initiating the creative process."

The responsibility for "fancy drafting" should, I think, be placed on our shoulders; we were the ones who placed the emphasis on skill and neatness and meticulous detail. Before industry can change, we are going to have to change the thinking of our own graduates.

Your editorial gives us a new and powerful tool for use in the reorganization of engineering drawing courses.

—J. C. SHIGLEY
Head, Dept. of Drawing & Design
The Clemson Agricultural College

To the Editor:

Apropos your December editorial, "Expensive Fancies," we certainly agree. In fact we extend this somewhat, and for small items to be made in the shop we find that sketches, particularly in isometric, are suitable and drastically cut drafting expense.

We also find and advocate the use of color in showing parts in a sketch. The shop mechanic "gets the picture" in a flash when it is in color as compared to cross-hatching or shading. The coloring only takes several minutes.

As an extension of the color idea we have experimented with coloring the assembly drawing and then putting the same color on the shop part working drawing as it appears in the assembly. A part drawing can then more easily be found in a file when it is needed for an assembly.

Another interesting sidelight is that the "office" more readily understands an assembly when it is colored. The unfortunate thing about this idea is that we do not have print duplicators that handle color; the idea is just ahead of its time.

Incidentally, the assembly can be colored more quickly than it can be

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cross-hatched in code. We might also have a material color code: nickel—green, copper—brown, etc.

—H. L. RATCHFORD
Sylvania Electric Products, Inc.

To the Editor:

Your December editorial on "Expensive Fancies" in the drafting room will, I am sure, stir up quite a controversy. I believe it is a very good job. Would it be possible to obtain about a half dozen reprints of the editorial to circulate among acquaintances who need some convincing as to the merits of "simplified drafting"?

—JOHN B. FARLEY
The Middleville Co.

To the Editor:

Your editorial in the December 1953 issue is probably your reply to various ideas on the simplification of drafting procedure previously discussed with you.

The majority of drawings are made with pencil, because ink is far too slow and too costly. I have found that pencil hardness "F" prints a nice white line and is okay.

Standard pencil sharpeners give a beautifully tapered point, but any line over 6 in. or 8 in. long commences to widen so much that a newly sharpened pencil should be picked up if you want to make a drawing with uniform width of line. I use a dozen of them, sharpened all at once, to save time.

If the cutters of a pencil sharpener were special ground, they could turn out a pencil that had a cylindrical point 0.035 in. dia by 0.040 in. long to extend down beyond the present standard taper.

I ask for a diameter of 0.35 in. so that sufficient strength in the lead can be had for ordinary use. I ask for a cylindrical length of 0.40 in. purely on a strength basis found by trial and test.

A sharpener of this nature would look just like any other sharpener and would be worth fully $25.00 to any draftsman or company. Once the master grinding wheel is formed, it would cost no more to make than any other sharpener and could be retailed for $7.50.

Today the labor cost is so high that hand sharpening of pencils is obsolete. Besides, they never would be uniform and could never draw a uniform width

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FOR ALL APPLICATIONS

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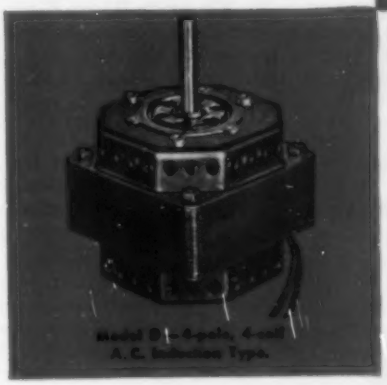

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Automatic Record Changers

Complete information, including specifications and dimensions will be mailed promptly upon request.

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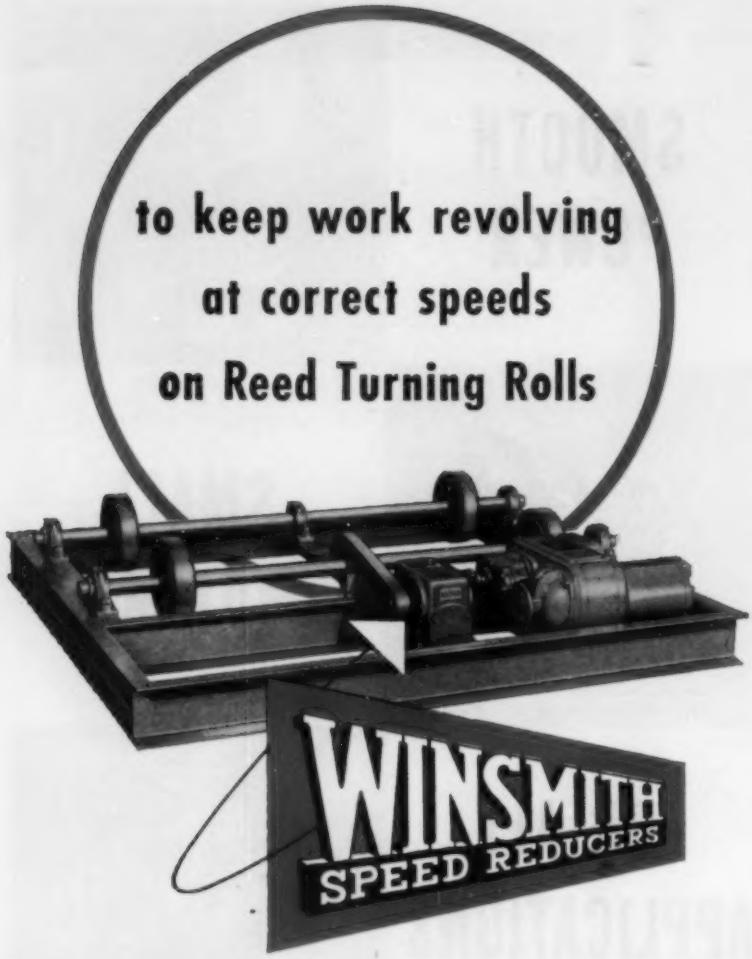

Rotating tanks, cylinders and pipes weighing up to 2000 lbs. for welding, painting or flame cutting, this Turning Roll, manufactured by Reed Engineering Company, is quickly adjustable to handle any diameter from 3″ to 6′ and any length from 12″ to 12′.

Powered by a ½ hp, 3-phase motor, a reversible Winsmith Worm Gear Speed Reducer, in conjunction with a variable speed drive, provides the uniform rotation needed here. Correct turning speeds are assured!

On the basis of ruggedness, compactness and freedom from maintenance, Winsmith Speed Reducers are rated first by first-rating producers of numerous types of equipment.

To fit your speed reduction requirements within the 1/100 to 85 hp range, in ratios of 1.1:1 to 50,000:1, the Winsmith line of fully standardized worm, helical and differential designs is most complete. For details, request Catalog 148.

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111 EATON ST.
Springville (Erie County), N. Y.

of line, which is absolutely necessary to making a good looking blueprint.

I have paid the machinist bills for several months trying to find out what is needed. I am not a manufacturer; I canont spend more now. I have paid the cost of the experimenting to find out what to ask for. Now I want to see a manufacturer make a sharpener.

Your December issue is a masterpiece. —CHARLES P. GRIMES
Grimes Engineering

To the Editor:

Your editorial in the December 1953 issue of *Product Engineering* leaves no doubt with respect to your own position in the controversy regarding relative merits of conventional drafting practice vs so-called "simplified" drafting practice.

As you said, many engineers will oppose the simplified practice. I can also agree that economics will sooner or later decide the issue, but contrary to your prophecy—I believe the simplified technique will be discredited.
—W. L. BARTH
G. M. Engineering Standards
General Motors Corp.

Ed—Economics will decide. In the meantime, we welcome more opinions.

Help Wanted

To the Editor:

As a subscriber to *Product Engineering,* I enjoy reading many articles in each issue and usually obtain reprints of those that are of the most interest.

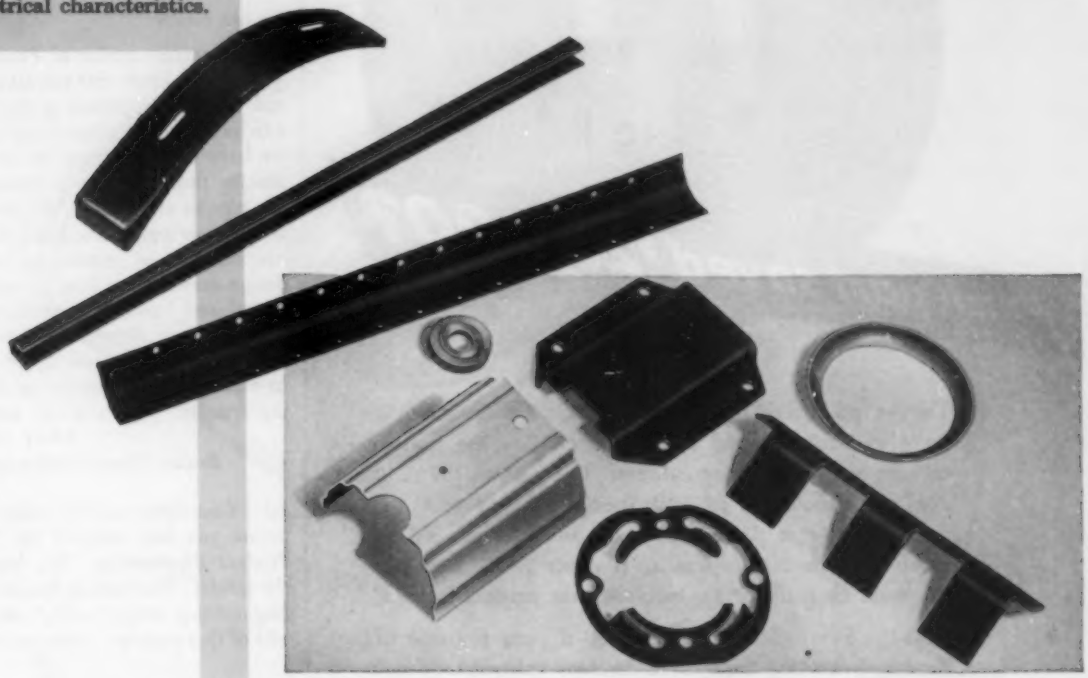
In the December issue there is an article entitled "Designing Curved Surfaces" that is most unusual and useful to me. I would appreciate the opportunity of obtaining a reprint or tear sheet.

If available, I would also appreciate a copy of the articles referred to in the bibliography. I would like to see more articles concerning the fundamentals of appearance design, design proportions, etc., and would be interested in any past articles that relate to this subject. —E. J. PERROTT
Chief Engineer
Miller Metal Products, Inc.

Ed—Tear sheets of all but two of the articles mentioned in the bibliography are on their way to you. These two are

TAYLOR Forming Materials are specially made for use in intricate shapes, compound curves and relatively deep draws. They are available with a wide variety of physical, mechanical and electrical characteristics.

Want to make something of them?



Make them into all kinds of panels, guards, barriers, ribs, masks, covers, ducts, containers, shields, shims or any other complicated formed part your product may require. While many grades of Taylor Vulcanized Fibre and Laminated Plastic can be formed to some degree, these four grades are ideally suited for most forming operations.

LAMINATED PLASTICS:

Grade C-7—for applications requiring toughness, resilience, mechanical strength and abrasion resistance.

Grade XX-7—for applications where mechanical strength is secondary to good electrical properties and low cost.

VULCANIZED FIBRE:

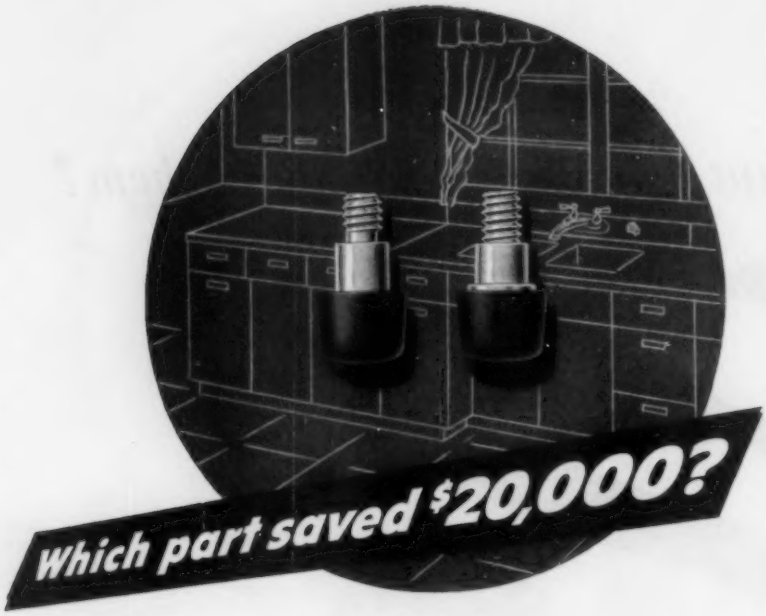
Trunk Fibre—for applications requiring good mechanical strength, toughness, abrasion resistance, surface finish and resistance to organic solvents.

Taylor Insulation—for applications requiring superior dielectric strength, toughness and abrasion resistance as well as good mechanical strength.

Make your products better and easier to assemble. Call your Taylor Engineer, he will be glad to work with you on your design problems and recommend the Taylor material that can be best formed to meet your particular requirements. Other grades of Taylor Vulcanized Fibre . . . as well as Phenol, Melamine and Silicone Laminated Plastics . . . may also fit into your design plans. Your Taylor Engineer will be glad to show you samples and discuss specifications.

Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California

TAYLOR
Laminated Plastics
Vulcanized Fibre



They're practically *look-alikes.* Both were designed to serve as rubber-tipped leveling screws on the bottom corners of metal kitchen cabinets. The part on the right does much the better job – its special collar prevents the rubber cap from slipping over the shank. Produced on COLD FORMING equipment, *it costs $6.00 less per thousand than the screw machine part previously used!*

Result: Savings of over $20,000 a year for one of America's leading makers of kitchen cabinets!

COLD FORMING and Good Design turned the trick!

Your annual investment for fasteners and small special parts is undoubtedly substantial in your plant. Savings that total thousands of dollars are not unusual when such parts are COLD FORMED without waste or scrap on high-speed automatic equipment and designed for high-speed automatic or semi-automatic application.

Thanks to long experience in COLD FORMING, Milford engineers, designers and product research experts are ready and able to help you cut small-parts costs substantially. They bring to your service Milford's leadership and know-how in the manufacture of semi-tubular, tubular and special rivets, as well as automatic rivet-setting machines.

So put us to work for you* — on products you're making *now* or those you're *planning* to produce. Chances are we can help you make some major savings — in both *time* and *money!

Write or phone nearest Milford Plant or Sales Representative!

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not available in tear sheet form, but photostats can be made at a cost of 40 cents a page. The book, "Engineering Drawing," mentioned in the bibliography can be purchased at any technical book store.

To the Editor:

As a regular reader of *Product Engineering,* I know that you take a clear and complete approach to the various articles covered. Commencing in 1952, we have made a library of all design articles that relate even remotely to our type of machinery. We have need now for an article discussing the various methods of numbering machine design drawings, such as the universal, coated and functional methods. Perhaps you have covered this material in a previous article and could supply us with some information on numbering systems. —R. A. ANDREWS
Chief Engineer
Brown Citrus Machinery Corp.

Ed—Your letter was obviously mailed before you had received the January *Product Engineering.* We hope that the article, "Numbering Systems in the Engineering Department," on page 194 of that issue was what you wanted.

Symbol Stamps Not New

To the Editor:

I was surprised to find on page 213 of your magazine of November, an article on "Symbol Stamps."

This method I have known for more than fifteen years as a very big time saver in cases where layouts or primary schematics are to be made. I myself had a complete set of such stamps for motor starting parts (starters, contactors, timers, etc.) and meters. These stamps were made on exact scale (1 cm = 1 in.) and used on squared tracing paper (1 square = ½ cm). To lay out a complete control board was a matter of only a few minutes, while the space of a normal office desk was sufficient. The drilling layout was made on the squared paper, the same as the primary schematic (using diagrams in my native country).

With use of a good tracing paper and stamps, drafting work is limited to a minimum.

—G. VAN DEN BRANDE
Toronto, Ontario

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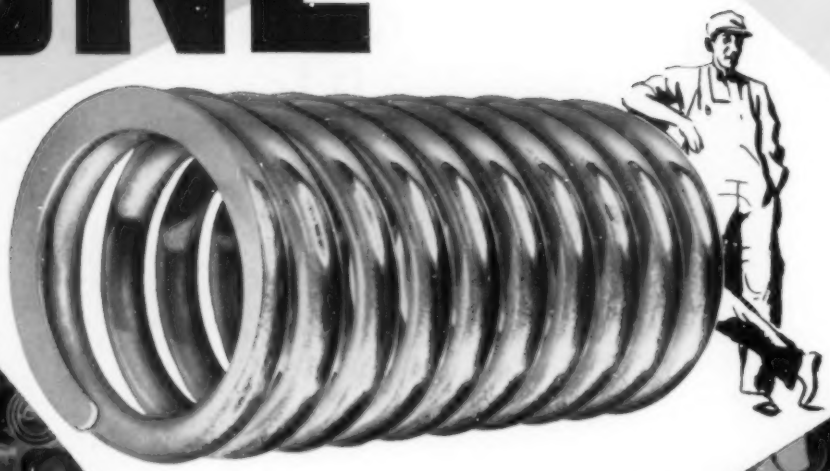

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NEW BOOKS

Spending for Industrial Research 1951-1952

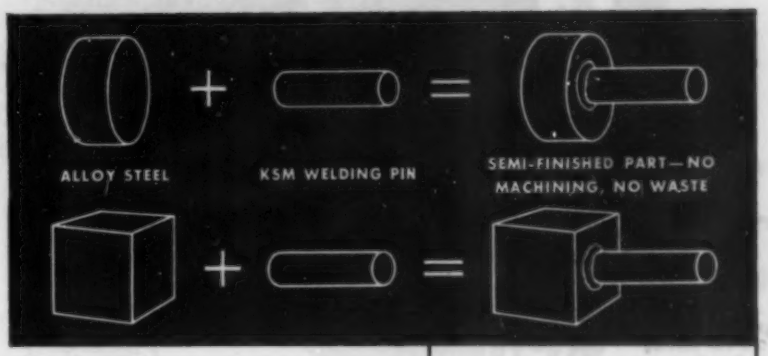
DEWITT C. DEARBORN, ROSE W. KNEZNEK and R. N. ANTHONY, *Harvard University. Paper bound,* 8½ x 11 *in.,* 102 *pp. Published by Division of Research, Harvard Business School, Boston* 63, *Mass.* $2.50.

There is much to be learned about the effectiveness of industrial research activities, the relationships among research, industrial growth and industrial profitability, and the factors involved in management decisions as to appropriate magnitudes of expenditures for research. An earlier study by Professor Robert N. Anthony, assisted by John S. May, "Management Controls in Industrial Research Organizations," published by the Division of Research at Harvard Business School in 1952, dealt with the management control practices in research organizations. The present study represents a modest—but important—investigation of the magnitude of industrial research activities; it provides some of the basic quantitative information as to such activities, including the scale of expenditures for research and development by industrial firms and the variations of such expenditures among firms by industry and by size. Such information in itself will be of significant value to industrial firms and others concerned with the scope and character of research activities. The data also provide some of the necessary foundation for additional research in this area.

This bulletin reports on the results of three coordinated surveys of spending for research and development by industrial companies in 1951 and 1952. The impetus for these studies came from the Research and Development Board of the Department of Defense (now the Office of the Assistant Secretary of Defense for Research and Development), the Office of Naval Research, the Industrial Research Institute, Inc., and the Committee on Research of the National Association of Manufacturers. The objective of each of these groups was to some extent different from that of the others, but there was a sufficient degree of overlapping interest to make it desira-

improved stud welding
through **K S M** engineering

A-MP SAVES
50% OF RAW MATERIAL...
70% OF PRODUCTION TIME
with switch to KSM ARC-WELDED PINS



Aircraft-Marine Products, Inc., Harrisburg, Pa., makers of solderless electrical connections and the tools for applying them, recently cut in half the material cost of two vital crimping-tool parts. They're also saving $10,500 per year (70% of the former cost) in machining time on indenter-and-nest sets alone—all through the adoption of KSM arc-welded pins, eliminating costly machining operations by stud-welding.

Using an automatic KSM production unit, your operator can weld as many as twenty studs a minute, accurately placed within .005"; and KSM studs, threaded, bent or plain, are available in many, *many* standard sizes—or can be engineered to your needs.

HOW A-MP DID IT

Instead of turning each indenter and nest, including the shank, out of a single piece of costly alloy steel, expending half the raw material in the process, A-MP now stud-welds KSM pins to steel blocks half the previous size, saves valuable lathe time, gets results as good if not better. A simple jig in conjunction with an arbor-mounted stud-welding gun permits welding speeds up to six studs per minute.

If you're dissatisfied with costly machining that KSM stud-welding could eliminate or simplify, A-MP's saving could well be *your* saving. Find out—write KSM Products, Inc., Merchantville 8, New Jersey.

KSM
STUD WELDING

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This new TYPE TS MINIATURE RELAY is only 1 7/32" x 2 3/32" x 1 7/32" in size for a 4 P.D.T. combination, yet mighty in performance. Withstands 25G shock and 10G vibration (up to 55 CPS). Ambient temperature range, −55°C to +85°C. Open type with contact combinations up to 6-pole, single throw. Hermetically sealed type with contacts up to 4-pole double throw. Send for details now!
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RELAYS • SOLENOIDS • COILS • TRANSFORMERS • SWITCHES • HERMETIC SEALING

ble for each of them to join their separate efforts.

The Division of Research of the Harvard Business School was asked to undertake two of these surveys: one of a large cross-section of industrial companies, and the other of a selected group of companies known to have relatively large research organizations. The third survey was directed to all industrial companies believed to do research, and was conducted by the U. S. Bureau of Labor Statistics, and the Research and Development Board.

Specifically, this publication covers the two surveys conducted by the Harvard Business School, and that part of the third survey relating to industrial research spending. A separate report on the third survey, to be titled "Scientific Research and Development in American Industry," is being prepared by the U. S. Bureau of Labor Statistics.

American Standard Plain Washers (ASA B27.2-1953)

8½ x 11 *in.*, 5 *pp. Published by the American Society of Mechanical Engineers, 29 West 39 St., New York* 18, *N. Y.*, $1.

This standard, dated March 30, 1953, covers plain washers for general industrial applications. It includes parts made of ferrous, non-ferrous and plastic materials.

Stability Theory of Differential Equations

RICHARD BELLMAN, *The Rand Corp.*, 6 x 9 *in.*, 166 *pp. Published by McGraw-Hill Book Co.*, 330 *W. 42nd St., New York* 36, *N. Y.*, $5.50.

This graduate text on an important aspect of mathematics furnishes an inintroduction to the modern theory of stability and asympotic behavior of solutions of linear and non-linear differential equations.

The linear equation with constant and almost-constant coefficients is treated in this book in great detail, using matrix theory. To make the book as self-contained as possible, the results in matrix theory are derived from the beginning, assuming no previous acquaintance with matrix theory. The results of the linear theory are used to derive results of Poincare and Lia-

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HOSE CLAMPS

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General Electric Diplexer and 500 Foot Antenna use scores of Worm Gear Clamps

● One of the country's most powerful UHF TV stations — WVEC-TV — made news when it opened recently to blanket the Norfolk, Virginia, area.

In keeping with its choice of advanced equipment, WVEC selected the new General Electric 12 KW transmitter which, with antenna gain, affords an output of approximately 200,000 watts.

A feature of the transmitter is the new G.E. UHF Diplexer that puts out the audio and video signals on the one antenna.

To solve an exacting multiple fastening problem simply, scores of AERO-SEAL Hose clamps are used throughout the G.E. Diplexer and at frequent intervals along the antenna.

AERO-SEAL Hose Clamps afford tight, never-let-go fastening quickly and simply. A twist of the wrist and the precision worm gear tightens with even pressure, locks to stay. Yet the clamp can be removed in a jiffy, used over and over. Stainless steel bands solve the corrosion problem. Investigate AERO-SEALS for your next special fastening job. Wide range of sizes. Samples on request.

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pounoff concerning stability of non-linear systems.

Following this, a survey of the important results concerning the boundedness, stability and asymptotic behavior of second-order, linear, differential equations is presented. The last two chapters are devoted to some important non-linear differential equations whose solutions may be completely described as far as asymptotic behavior is concerned.

It is the first book in English covering in any detail that part of the modern theory of boundedness, stability, and asymptotic behavior of linear and non-linear differential equations, which is distinct from the theory of periodic solutions. Most of the material is original with the author or is taken from original research papers.

Finally, the treatment of matrix theory required for differential equations will not be found in any text on matric theory.

Plastics Progress—1953

Papers and discussion at the British Plastics Convention 1953. *Published for "British Plastics" by Illife & Sons, Ltd., Dorset House, London,* 9¾ x 6 *in.,* 439 *pp.* $7.

This book is an up-to-date report on several important branches of plastics technology, based on the papers given and the discussions following them in the British Plastics Convention held in June 1953. Contents cover plastics materials, methods and uses. There is special emphasis on glass and asbestos reinforced plastics, and six papers are devoted to this subject, including the first publication of collected data on the properties of asbestos reinforced plastics. This paper was described in discussion as "the reference work on asbestos/phenolic materials." Another rapidly developing material is unplasticised polyvinyl chloride in various forms, and it is indicative of current interest that two chapters (one on composition and another on properties, fabrication and uses) are given to this subject. Other material developments are reported in chapters on melamine resins, polyamides and polyesters, and silicone resins.

Molding problems are described under two heads: one author deals with the economics of large moldings, while

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The BASIC four-channel assembly includes: Cabinet, Recorder, and, for each channel, a BUILT-IN unit (A), which comprises a Driver Amplifier with frame, and a Power Supply with control panel.

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You have a CHOICE of readily interchangeable, plug-in Preamplifiers (B) for EACH channel, as described below.

A NEW design concept that brings even greater versatility to industrial OSCILLOGRAPHIC RECORDING

The new Sanborn 150 Series offers greater operating efficiency and convenience, and encompasses a *variety of uses* which include the accurate recording of almost every phenomenon whose frequency spectrum lies in the range from 0 to 100 cycles per second.

A *wide selection* of plug-in preamplifiers, or "front end" units, such as (B) above, are completely interchangeable in any or all channels of the 150 Series amplifier section, where they simply plug in to the driver amplifier and power supply, (A) above, which are already in place.

Available plug-in Preamplifiers include: AC-DC, CARRIER, SERVO-MONITOR, DC COUPLING, LOG-AUDIO, and LOW LEVEL. Blank plug-in assemblies are also available for users to make input circuits for special measurement problems.

And, there are the popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

A new catalog on Sanborn Oscillographic Recording Systems and their components will be sent gladly on request.

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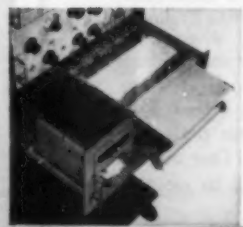
- Extended frequency response.
- Improved regulated power supply.
- Individual stylus temperature control for EACH channel.
- Improved, single control, paper speed selector. Nine speeds — 0.25 to 100 mm/sec.
- Recorder slides out, if desired, for better view of recorded events, or for notations on record (illustrated at right).
- Improved control of input signals by use of 1, 2, 5 ratios on attenuator.



Be sure to see the 150 Series at BOOTHS 455–457, I.R.E. Convention, Kingsbridge Armory, Bronx, N. Y. March 22–25, 1954.

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Pick 'DIAMOND H' RELAYS

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...FOR HIGHER VIBRATION RESISTANCE

Vibration resistance range of "Diamond H" Series R Relays has been more than doubled, extending now from 0 to well over 1,000 cycles per second at 15 "G's."

Continuing engineering developments such as this are constantly broadening the adaptability of Series R Relays for a wide variety of applications . . . guided missiles, jet aircraft, fire control and detection, radar, communications, high speed camera, geophysical and computer apparatus . . . and similar applications requiring positive operation under critical conditions.

Hermetically sealed, miniature aircraft relays, Series R devices are basically 4PDT, but are also available in DPDT and 4PDT with two independent coils, either or both of which will operate the unit. Available with all standard mounting arrangements, including ceramic socket for interchangeability. Their design permits unusually compact grouping and provides a firm bond between relay and chassis. See us for special arrangements.

In their field still the smallest and lightest, (1.6 cu. in., 3.76 oz.) combining highest operating shock resistance (to 50 "G" and higher), widest temperature range (−65° to +200° C.) and greatest ability to break high currents and high voltages, Series R Relays consistently operate over 400,000 cycles without failure at 5 A. and go 3,500 or more under 30 A. at 30 V., D.C., resistive. They carry voltages up to 300 D.C. at 4/10 A. for more than 400,000 cycles. With low contact loading, life expectancy is 10 million cycles or better.

Operating time is 10 ms. or less; drop out time 3 ms. or less. Coil resistances up to 35,000 ohms are standard; to 50,000 ohms available for special units. Sensitivity approaches 100 mw. at 30 "G" operational shock resistance. Inter-electrode capacitance is less than 5 mmf. contacts to case—less than 2½mmf. between contacts, even with plug-in type relay and socket.

Designed to meet all requirements of USAF Spec. MIL-R-5757B, they far surpass many. Bulletin R-150, giving basic performance data under varying conditions, is yours on request. Our engineers are prepared to work with you to develop variations to meet your specific requirements. Tell us your needs.

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another expert describes the factors involved in high quality injection molding. This latter paper contains much information hitherto unpublished, and an account of original investigations.

Developing fields for plastics are described in four chapters on new uses in industry. These selected fields are cables, vacuum coating, conveyor belting and footwear. The latter is a particularly thorough exposition of this subject which, though expanding has not been previously described in such detail.

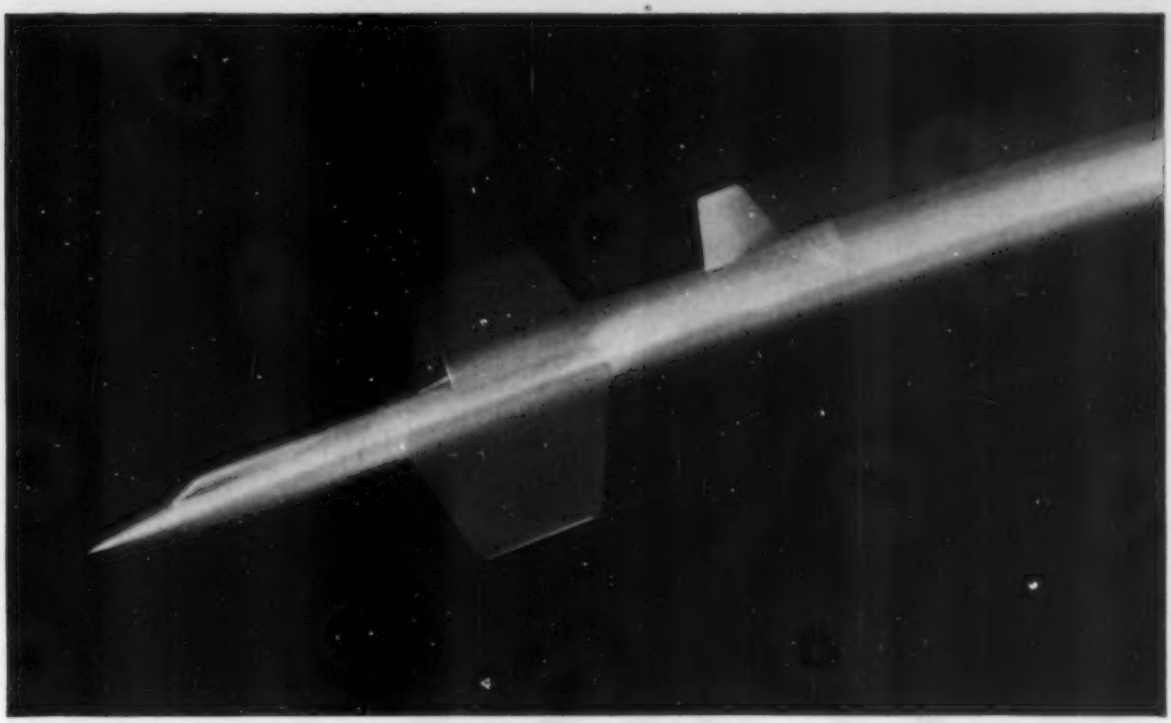
The text, while based on the papers given at the British Plastics Convention, allows for very much fuller treatment of the subjects than was possible in the limited time available to the lecturers. Many of the authors have taken the opportunity to expand their theses more fully, and the book as a result forms a valuable, detailed and authoritative contribution to current plastics technology.

Weld Standards

8½ x 11 *in.*, 19 *sheets. Published by the Lincoln Electric Co., Cleveland* 17, *Ohio.* $1.00 *in U.S.A.;* $1.50 *elsewhere.*

This set of weld standards has been made available to enable the engineers of machinery manufacturers and fabricators to acquire both cost and quality control over welding operations. The Standards are available on tracing paper so that they can be blueprinted or otherwise reproduced for the purpose of giving engineers and production personnel a standard for communicating welding procedure on drawings. They are based on procedures developed by Lincoln and the weld symbols of the American Welding Society.

A common problem to engineers and designers in designing for welded machines or structures is assuring that the welds are made as specified. This is a problem in both communication and cost and quality control. Weld Standards help solve both aspects of the problem. With a simple letter designation, they specify, according to plate thickness, both the type and size of weld as well as how it should be made. With both engineering and shop using the same standards and having print of the standards available at all times, the engineer can be



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For a specified plate thickness, the electrode type and size, the polarity and current, electrode melt-off rate, arc speed, number of passes or beads, feet of join welded per hour, and the pounds of electrode required per foot of weld are given. All of these factors are specified by using the Weld Standard designation in conjunction with the regular American Welding Society symbol. Standards have been prepared for manual welding of butt welds, fillet welds, lap and corner welds in all positions in both plate and sheet metal.

Principles of Numerical Analysis

A. S. HOUSEHOLDER, *Oak Ridge National Lab., 6 x 9 in., 275 pp. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.,* **$5.**

This is a unified presentation that develops the mathematical principles upon which many computing methods are based and in the light of which they can be assessed. It is designed for senior-graduate courses, the mathematician, and directors of computing groups who wish to invent, improve, and evaluate techniques. The work is self-contained and understandable without instructional assistance. Treatment is primarily theoretical.

The book is directed primarily toward digital computation and techniques for making estimates of errors are indicated wherever possible. Functional equations as such are not discussed, but emphasis is placed upon the methods of solving the finite systems, and performing the interpolations which are required in the digital solution of functional equations. The aim is always to give a unified treatment rather than a complete catalog of methods; to develop only a few principles, but to develop them thoroughly.

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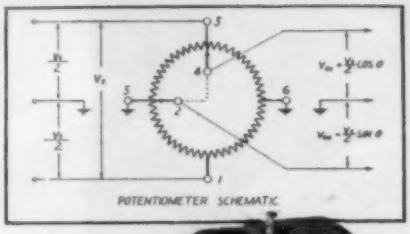

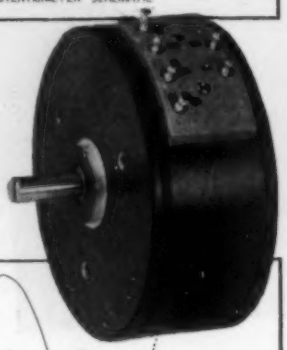

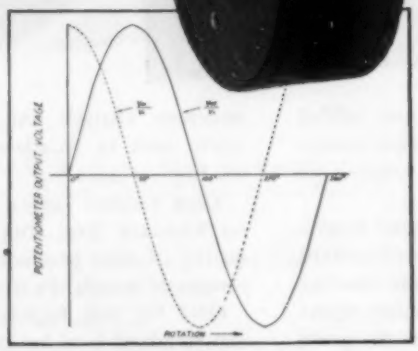

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summer of 1952 and many recent developments are exclusive in this book. Development is most marked in matrix applications, both inversion and the determination of proper (or eigen-) values and vectors, and a number of new methods are discussed and related to older techniques.

To make material available to a wider class of readers the attempt was made to develop all the necessary theory of matrices and determinants, and the theory of equations; and to presuppose only as much of the theory of complex variables as may be expected of a student whose mathematical preparation does not go beyond calculus.

Chapter heads are as follows: The Art of Computation; Matrices and Linear Equations; non-linear Equations and Systems; The Proper Values and Vectors of a Matrix; Interpolation; More General Methods of Approximation; Numerical Integration and Differentiation; and The Monte Carlo Method.

Theory and Design of Steam and Gas Turbines

JOHN F. LEE, *Asso. Prof. of Mech. Engrg., North Carolina State College. 6 x 9 in., 502 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. $9.*

This is the first complete and fundamental treatment of steam and gas turbines since Stodola. The book is mainly concerned with two things: first, to provide a textbook for use in graduate and undergraduate mechanical engineering curriculum which will force the student to make extensive use of the fundamental knowledge acquired in the basic courses; and second, to furnish the practicing mechanical engineer with a fundamental background that will be of value in making contributions to this rapidly developing field.

The author presents the modern theory of turbine flow passage design in a manner understandable to the mechanical engineer who may not have a background in aerodynamics or gas dynamics. Theory is critically examined and thoroughly explained. A guiding principle is to use the theory in design applications to the exclusion of empiricism wherever possible.

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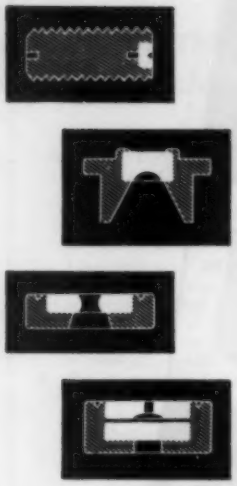

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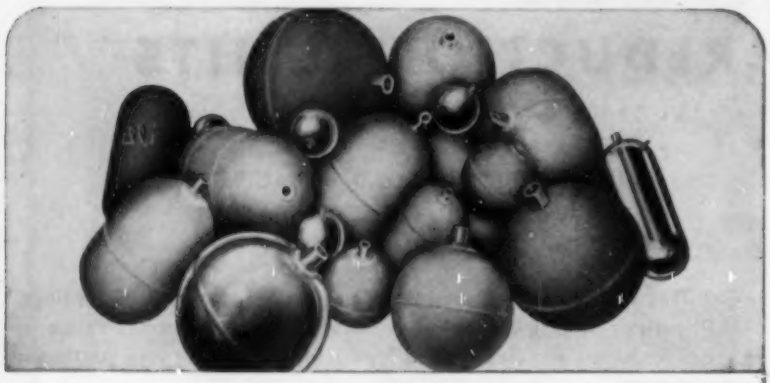

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to change and is readily available in the literature, is introduced only to the extent necessary to establish physical concepts in the mind of the student. The theory common to all comprehensible-fluid machinery is treated first, with extension and application of the theory to steam turbines, gas turbines, axial-flow compressors and centrifugal compressors. Combustion is treated from a fundamental standpoint instead of merely describing burners or the combustion process in general terms. Steam and gas turbine power cycles are completely treated both from the ideal and non-ideal standpoint.

Welding Engineering

BONIFACE E. ROSSI, *Exec. Secretary of the Pressure Vessel Research Committee of the Welding Research Council; Special Lecturer on Welding, Stevens Institute.* 6 x 9 *in.*, 786 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 *W. 42nd St., New York* 36, *N. Y.* $8.

The aims of this work are: (1) to familiarize the student or beginner with certain welding fundamentals, (2) to give those now in the field a wider understanding of the process, and (3) to provide a useful source of reference for the draftsman, designer, engineer, researcher, executive and anyone else seeking information on welding and its applications.

In preparing this material, the author has reviewed much published and unpublished literature, including handbooks, textbooks, articles, reports and private correspondence listed in his bibliography.

Section one of the book covers various welding processes, such as forge, resistance, thermit, gas, pressure gase, arc, submerged arc, inert-gas-shielded arc, atomic hydrogen, stud, induction, flow and cold welding; it also covers soldering, brazing, surfacing, metallizing, oxygen and arc cutting of metals, and safe practices and health precautions.

Section two deals with metals, their metallurgy and visibility. Section three presents and discusses pertinent design and fabrication considerations, such as welded design and its field of application; types of joints, welds, and stress distribution; layer sequences, deposition rated, and welding costs; expansion, contraction, and residual stresses

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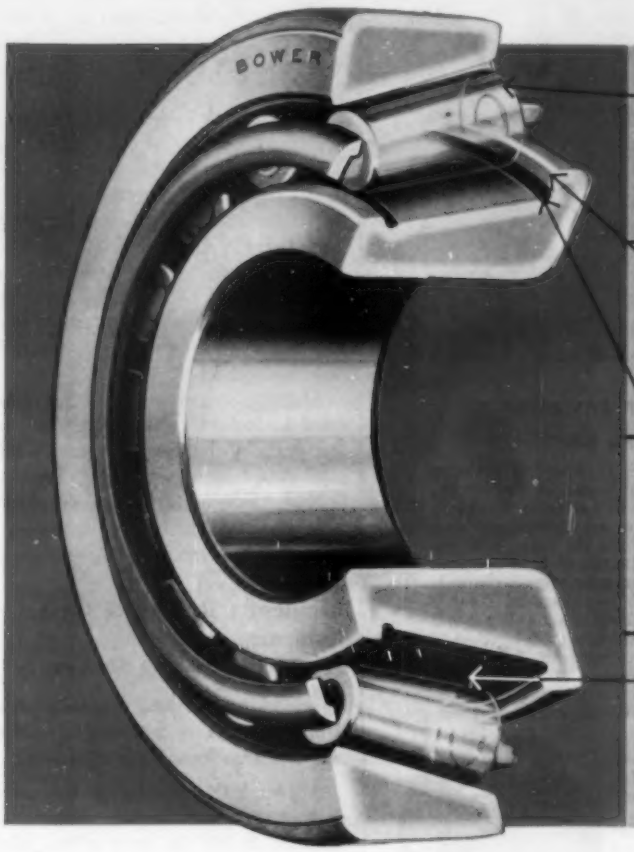

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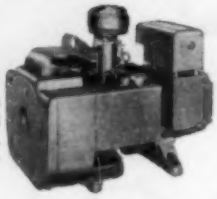

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in welding structures; welding jigs; and standard symbols adopted by the American Welding Society and their use.

Section four treats the testing and inspection of welds. These five extremely useful and important appendices are included: welding terms and their definitions; selected bibliography; visual aids; questions and problems; and engineering data and talks.

Special features claimed for the book are:—Text material is arranged in logical and practical sequence and presentation is based on the author's 13 years experience teaching the subject at the college, trade school and industrial training level.

—Recent developments in the field are covered, including several subdivisions on inert-gas-shielded arc welding and submerged arc welding, pressure gas welding, stud welding, cold welding, induction welding, and flow welding.

—This work includes the following topics, which, in most cases, have never before been treated in a work of this kind: cold welding; certain phases of submerged arc welding, such as multiple electrode submerged arc welding; certain phases of inert-gas-metal arc welding with consumable electrode, such as semiautomatic process; certain phases of metal-arc welding and multiple-arc welding.

—Material in this text has been tried in lecture form during the past five years by the author in his "Welding" course at the Industries Training School, Stevens Institute of Technology, Hoboken, N. J.

Minnesota Rubber & Gasket Company And The Injection Molding Process

8½ x 11¼ *in., 78 pp. Available from Minnesota Rubber & Gasket Co., Minneapolis* 16, *Minn.* $4.

Although this publication was originally intended only for limited distribution to tell the story of the Minnesota Rubber & Gasket Co., it is being made available at less-than-cost because of the many requests that have already been received.

It contains a wealth of sound engineering data pertinent to the design, manufacture and test of injection molded products made from natural and synthetic rubbers. For example,

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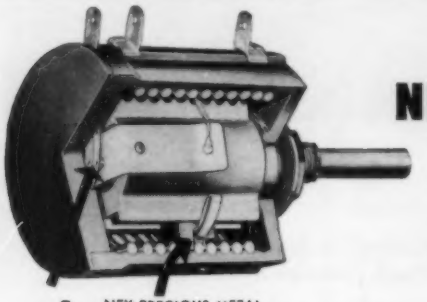

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one table classifies and compares the physical properties of synthetic rubbers. Another lists AMS Specification Numbers, Applications, Temperature Range, Hardness and Minnesota Compound Number. A comprehensive outline of ASTM Standards and Methods of Test is also included.

Finally, there are considerable catalog data on O-rings, Quad-rings, U-cups, V-rings, and Leather Back-up Washers, all products that are manufactured by the company.

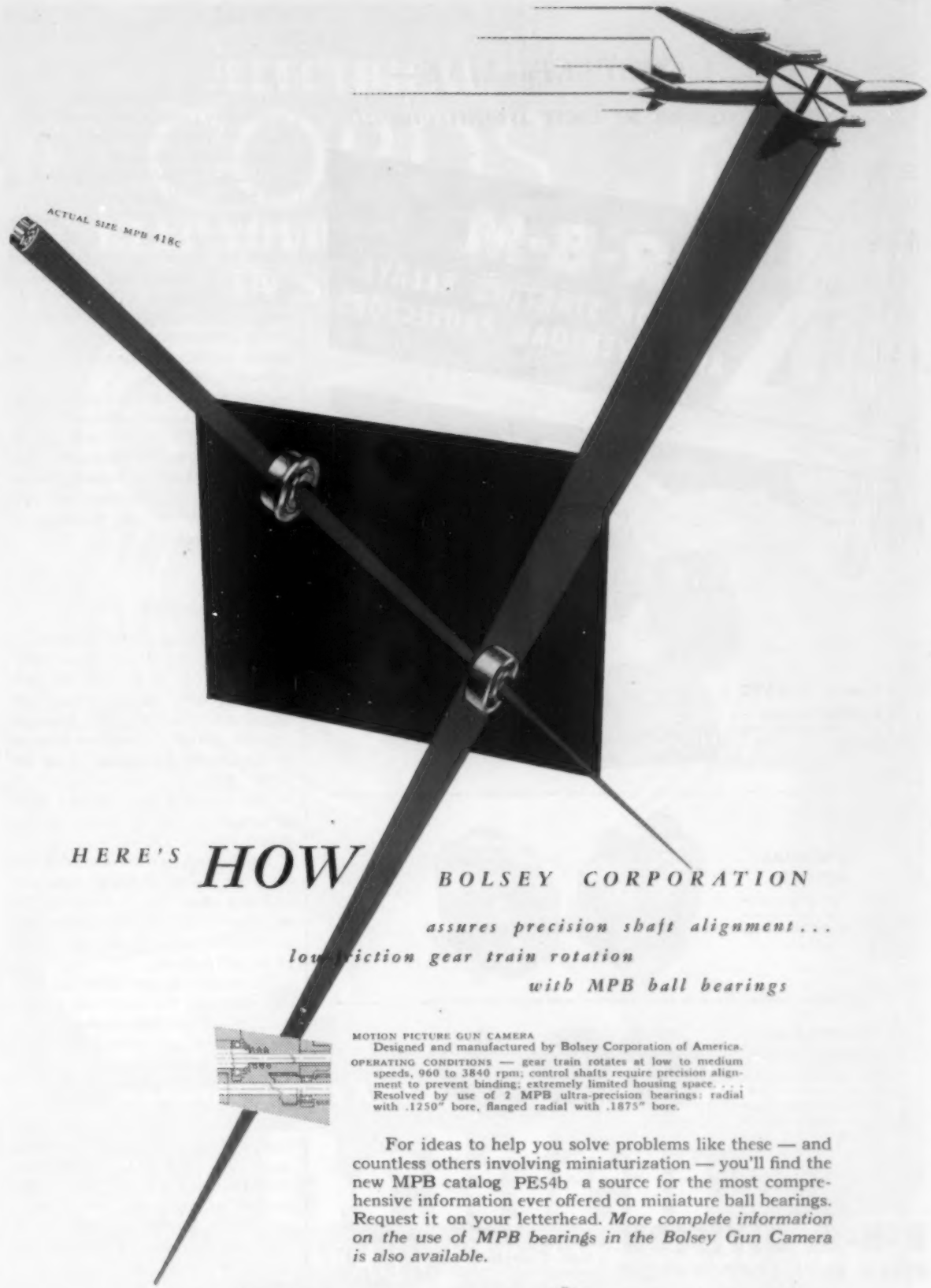
Instrument Engineering, Vol. II; Methods for Associating Mathematical Solutions With Common Forms

C. S. DRAPER, *Hd., Dept. of Aeronautical Engrg., Instrumentation Lab.*, W. MCKAY, *Associate Prof. of Aeronautical Engrg., and* S. LEES, *Asst. Prof. of Aeronautical Engrg., Massachusetts Institute of Technology*, 9 x 11 *in.*, 827 *pp. Published by the McGraw-Hill Book Co., Inc.*, 330 *W. 42nd St., New York* 36, *N. Y.*, $15.

This is the second of a three-volume series that presents a generalized method of attack on the problems of measurement and control. This series is a comprehensive reference for the practicing engineer and a textbook of unusual completeness for students familiar with college physics and differential equations. Concepts, theory, methods and results are combined in a unified pattern that is effective in handling both simple and complicated situations.

This pattern is developed in three phases that are illustrated by examples based on measuring instruments, control system components, regulators, servo-mechanisms, feedback controllers and computers.

Volume II reviews the mathematical background of several methods for associating solutions with these descriptive forms, and illustrates procedures —by actual derivations—of quantitative results for a number of generally useful examples. The classical, Laplace transform, and weighting function methods for solving ordinary differential equations are developed in terms of nondimensional working variables. Procedures for using these methods are illustrated by a number of generally



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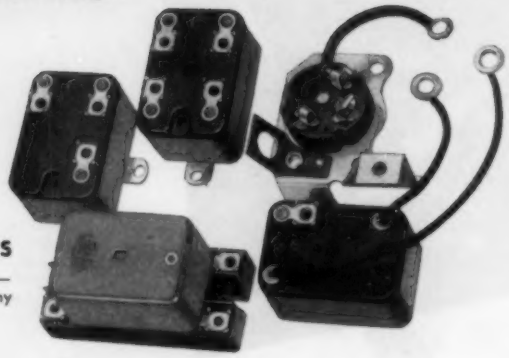

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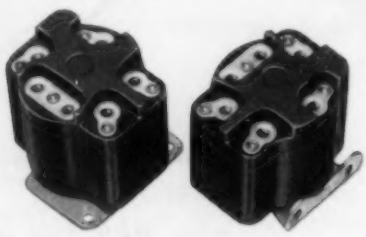

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applicable examples, with details shown for all the mathematical steps required to produce final results in the form of quantitative curves with dimensionless coordinates.

Volume I, Methods for Describing the Situations of Instrument Engineering, develops a system of concepts, notations, diagrams and mathematical forms for describing the performance of physical devices and variations in physical quantities. It provides a description of the physical circumstances under consideration by means of diagrams, mathematical forms, curves and numerical data.

Volume III, Applications of the Instrument Engineering Method, will be ready in 1954. It is made up of examples that use the materials of Volumes I and II for representing instrument engineering situations and finding solutions for the mathematical forms involved.

Servomechanisms

Vol. V of Selected British Government Research Reports, Issued by the Ministry of Supply in London and published by His Majesty's Stationery Office, 6 x 9 *in.,* 292 *pp. American Agents: British Information Services,* 30 *Rockefeller Plaza, New York* 20, *N. Y.,* $13.

This volume is the latest in a series of reports published regularly by the British Government.

The research reports collected herein have been selected from work carried out under the direction of the Ministry of Supply. Publication was undertaken primarily for the benefit of British Industry.

The reports do not follow any definite continuity but deal with specific methods and problems encountered in the theoretical and practical considerations of servomechanisms. Typical topics include: Operational Methods for Servo Systems; A Method for Evaluating the Roots of Quartic Equations and its Application in Servomechanism Theory; Quick Response Sense-Detecting Rectifier Circuit; The Presence of Air in Oil and Its Probable Effect on the Irreversibility of Hydraulic Transmission Systems; and The Linearity of the Voltage-Speed Characteristics of Small D-C Generators.

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Buy the components which comprise a servo system from several manufacturers, and chances are that you are butchering. After you waste time, labor, machinery, and material, modifying each component to make it usable, you still have to be satisfied with the limited system efficiency provided by unmatched units.

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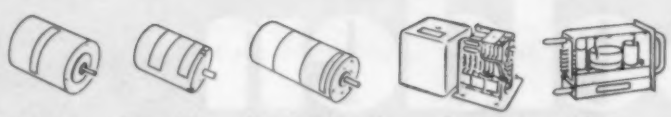

Miniature Control Motors | Motor and Gear Train Assemblies | Motor, Generator, and Gear Train Combinations | Servo Amplifiers | Plug-In Assemblies

NACE REORGANIZES TECHNICAL COMMITTEES

HOUSTON—National Association of Corrosion Engineers has streamlined its technical committee operation with a reorganization program that becomes effective on March 18, 1954. Biggest change: reduction of numbered committees from 19 to six. Reason for the change: to improve committee efficiency. No committee's function has been abolished.

The six new groups—to be called "Technical" committees in the future, instead of "Technical Practices" committee—are:

Technical Committee 1—Corrosion in Oil and Gas Well Equipment.

Technical Committee 2—Pipeline Corrosion.

Technical Committee 3—General; committees whose subjects cross industry lines.

Technical Committee 4—Utilities.

Technical Committee 5—Corrosion problems in the Process Industries.

Technical Committee 6—Protective coatings.

NACE has also just published a procedure manual for the functioning of these major subdivisions. The book covers such subjects as election of officers, establishment of new committees, approval of technical reports and termination of committees.

NEW FUSE LABORATORY

ORDNANCE CORPS, U. S. ARMY, has set up a new research group to handle the staff and facilities recently inherited from the National Bureau of Standards (*Product Engineering* September, 1953, p. 198). The Class II field installation has been named the Diamond Ordnance Fuse Laboratories (DOFL).

Scope of DOFL's work: research and development programs for fuses in non-rotated missiles, a classification that includes bombs, rockets, guided missiles and mortar shells but avoids artillery shells. The bulk of the labs' 1,400 staff members will continue to occupy 164,000 sq. ft of space on the grounds of NBS; in addition DOFL has taken over NBS field stations at La Plata, Pt. Mugu, China Lake, Las Cruces and Pomona.

standard O-M cylinders are easily and quickly modified to fit SPECIAL APPLICATIONS

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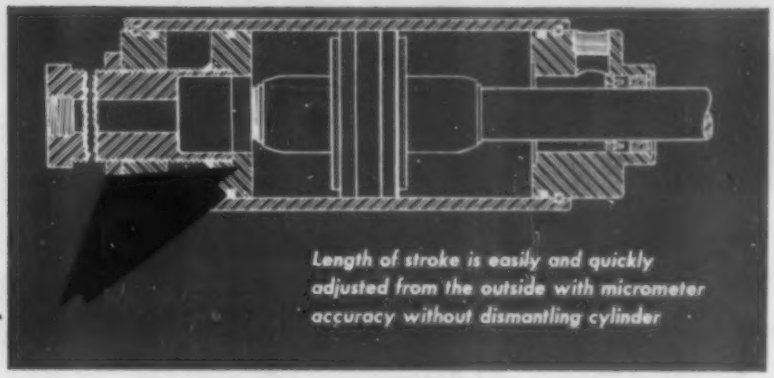

Length of stroke is easily and quickly adjusted from the outside with micrometer accuracy without dismantling cylinder

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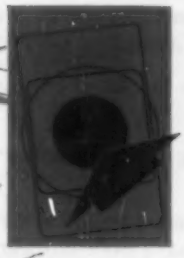

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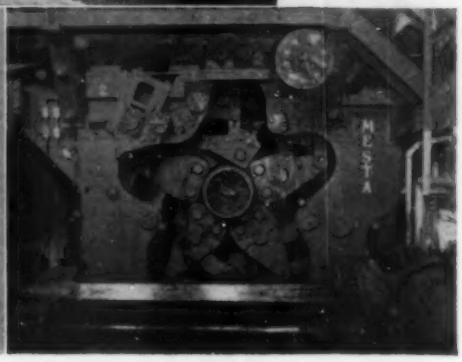

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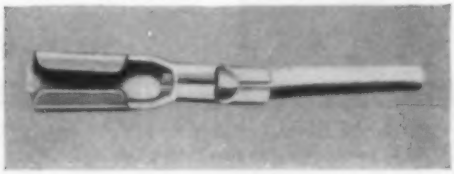

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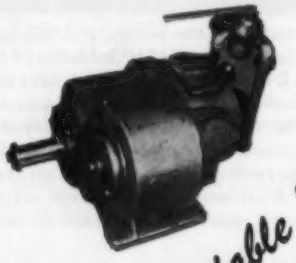

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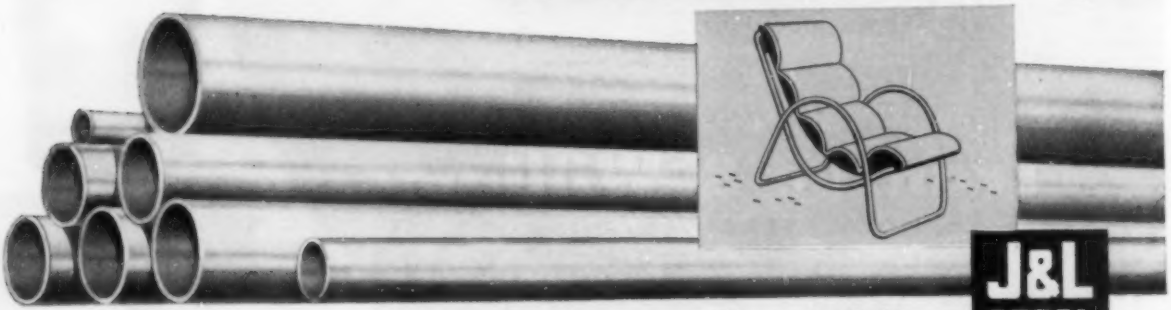

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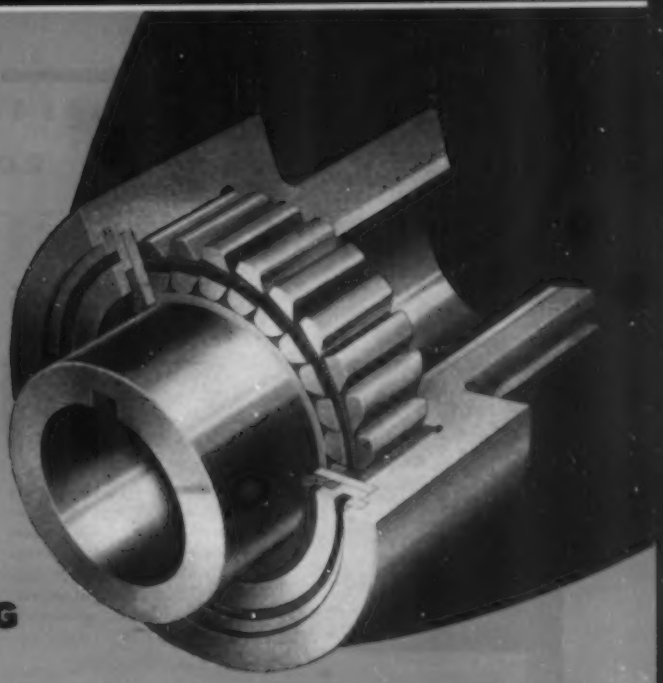

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Feeding was inaccurate because of the inherent backlash and speed was limited. It provided only one indexing position and one indexing rate, determined by the number of teeth. And, it was noisy.

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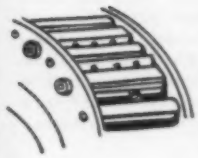

This type had widely spaced rollers. High capacity was not possible without many rollers, resulting in a bulky, space-taking clutch. Clutch life was short: the rollers always gripped at the same inner-race positions.

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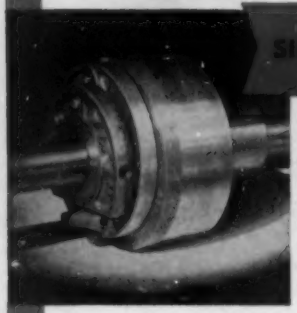

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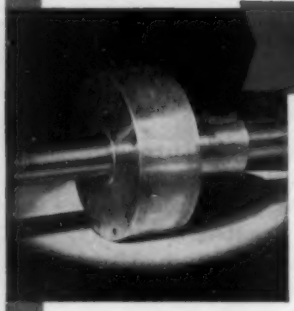

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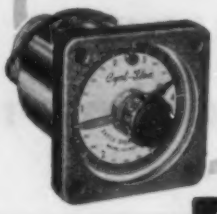

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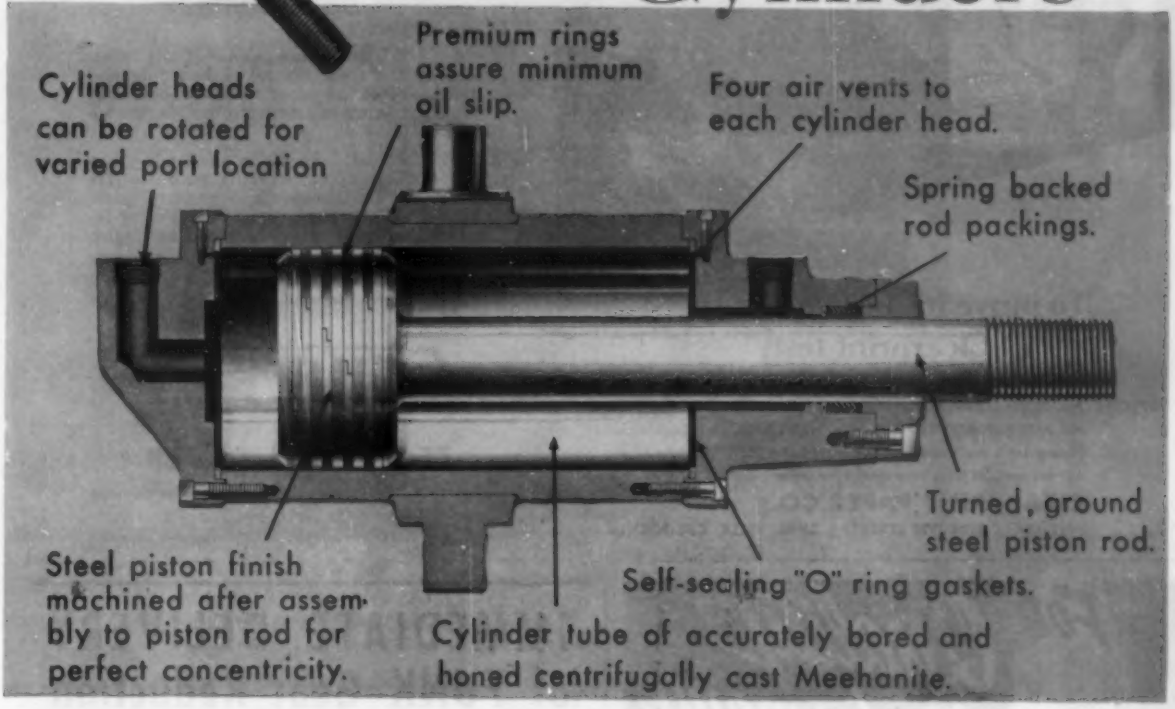
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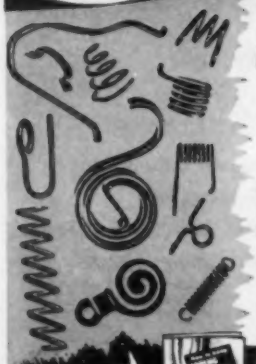

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DUTY CYCLE.....Continuous
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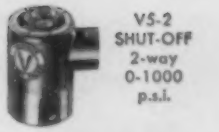
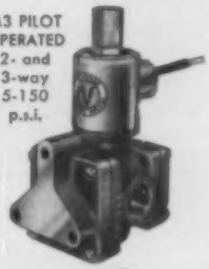
TEMPERATURE..... Minus 65°F. to Plus 150°F.

Modern production equipment and methods assure immediate delivery on stock valves, and highest quality standards. Valves are guaranteed for 1 year against defects in materials or workmanship.


VS-2 SHUT-OFF 2-way 0-1000 p.s.i.

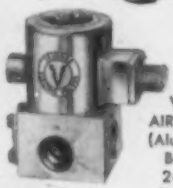
V10 HYDRAULIC 3-way 0-1000 p.s.i.


M3 PILOT OPERATED 2- and 3-way 5-150 p.s.i.

X5 EXPLOSION PROOF (V5 type) 2- and 3-way 0-1000 p.s.i.

VS-3 QUICK EXHAUST 3-way 0-150 p.s.i.

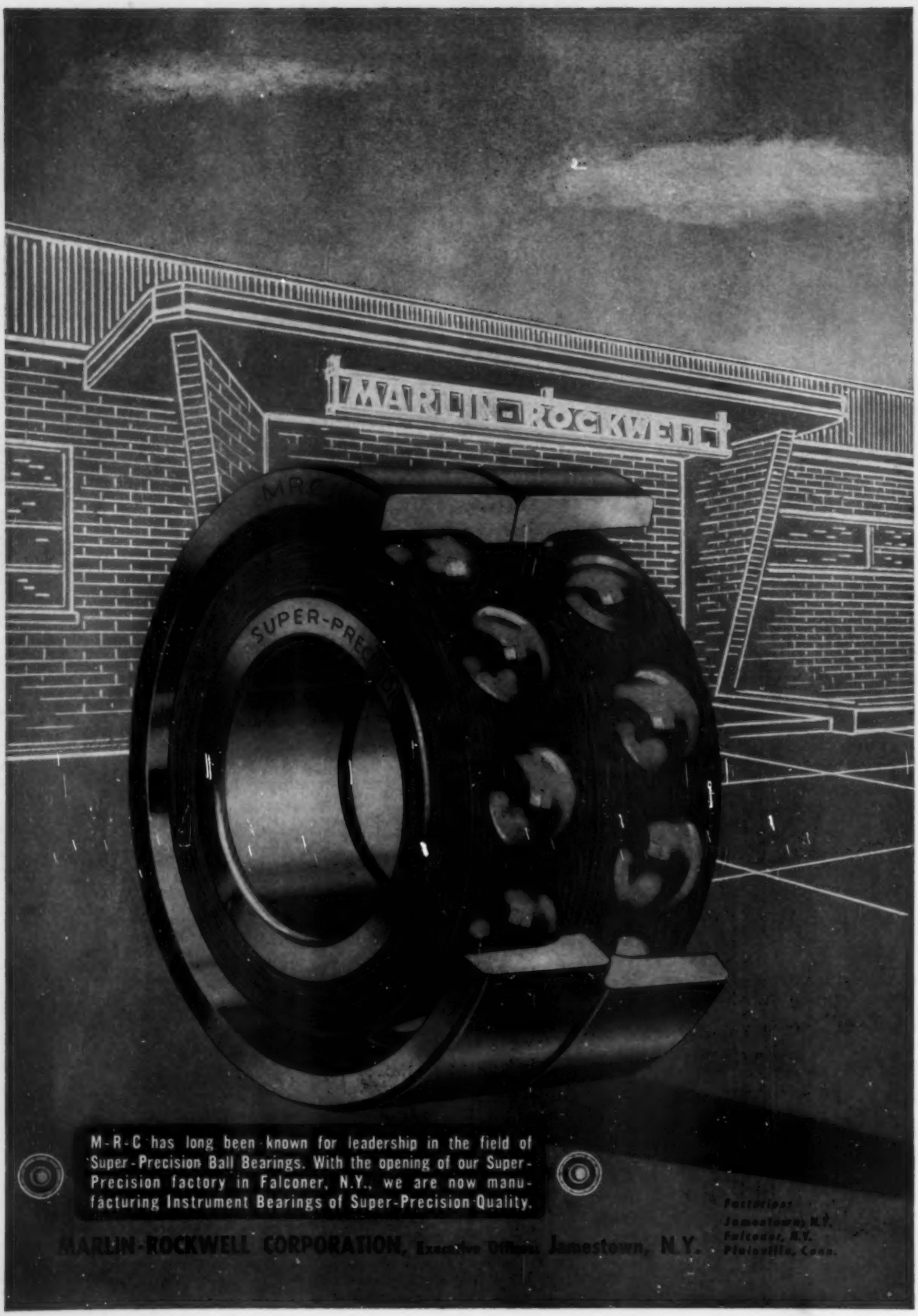
V2 SHUT-OFF 2-way 0-200 p.s.i.


V50 AIRCRAFT (Aluminum Body) 2-way 0-3000 p.s.i.

SKINNER ELECTRIC VALVES

SKINNER SOLENOID VALVES

SKINNER ELECTRIC VALVE DIV., The Skinner Chuck Company, 114 Edgewood Ave., New Britain, Connecticut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SUPER-PRE
M-R-C has long been known for leadership in the field of Super-Precision Ball Bearings. With the opening of our Super-Precision factory in Falconer, N.Y., we are now manufacturing Instrument Bearings of Super-Precision Quality.
MARLIN-ROCKWELL CORPORATION, Executive Offices: Jamestown, N.Y.
Factories:
Jamestown, N.Y.
Falconer, N.Y.
Plainville, Conn.

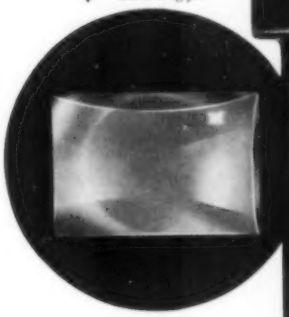
MICO-VUÉ, molded and assembled for Mico Photo Products, Chicago

Baby picture, Santa Fe Photo

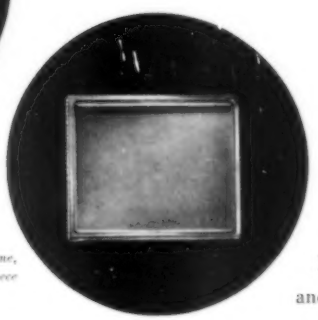
Inside side-section view, note insets

Outside side-sectional view, note design detailing

Fine optical glass lens, which, together with reflecting mirror, was included in our assembling job



Plastic lens hinged mount for magnifying glass



Plastic diffuser and frame, molded in one piece

NEW VIEWER

New View on what Plastics Can Do

You can draw some profitable conclusions for your own plastic products from these views of Mr. "Mike" Wolk, president of Mico Photo Products. Mr. Wolk said he wanted his viewer to be plastic not only because of the lower production cost, but for the greater attractiveness and color variety which he felt plastics afforded over other materials. This, then, was a complete start-to-finish molding and assembling job for us. Everything that went into this new viewer except its fine precision optical lenses and metal slides was made of plastic.

Economy and strength were the factors in molding the Mico-Vué with a minimum number of castings. The light diffuser and frame were molded in one piece for greater economy and more attractive appearance. Even the lens hinge mounts were molded. Although this viewer is new, the idea of doing a thorough engineering and molding job economically and beautifully is an old story with us. We'd like to tell you that story and show you how we can serve you. Just let us know when we may. We'll do the rest.

Write on your letterhead for the new Injection Molded and Extruded Plastics Catalog. Or, for detailed information about [redacted] piping, tubing and fittings, write for circulars containing data and illustrations.*

*Trademark Registered

ELMER E. MILLS CORPORATION

a subsidiary of **CONTINENTAL CAN COMPANY**

INJECTION MOLDERS and EXTRUDERS of: Tenite, Lumarith, Plastacele, Fibestos, Lucite, Nylon, Plexiglas, Polystyrene, Styron, Loalin, Vinylite, Geon, Plexene, Polyethylene, Corex, Forticel, [redacted]*, Saran, and other Thermoplastic Materials.

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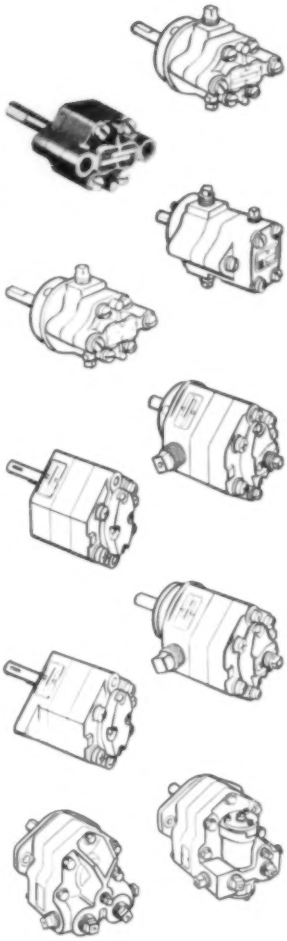
If You, too, Prefer a Built-in Hydraulic Pump...

Choose Yours from WEBSTER'S *90 types*



• The WEBSTER pump on this Joy Portable Compressor is face-mounted on the crankcase and gear-driven from the crankshaft. It is a compact, durable, positive displacement helical gear-type pump which provides force-feed lubrication.

This is but one of 90 types of WEBSTER Oil Hydraulic Pumps with capacities from 10 gph to 10 gpm—at pressures up to 1200 psi—speeds to 3600 rpm—with or without built-in relief valves—for sealed or wet sump mounting. One of these models might very well suit your needs because their custom-built design permits easy adaptation to your system.

***Write** today for catalog containing performance charts and pump data sheets on which you can describe your requirements.*

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE, WISCONSIN

ESTABLISHED 1909

"Where Quality is a Responsibility and Fair Dealing an Obligation"

MANUFACTURERS OF A COMPLETE LINE OF OIL HYDRAULIC PUMPS

THE DOOR TO OPPORTUNITY

Come right in! Join the watchmakers and other users of non-ferrous metals who find Riverside Alloys the Open Sesame to precision-manufacturing.

A century of service to the most exacting of crafts is your assurance of satisfaction with these fine metals . . . in sheet, strip, rod, wire, circles, blanks . . . of phosphor bronze, nickel silver, cupro nickel, and beryllium copper.

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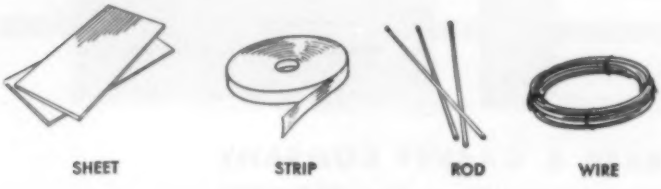
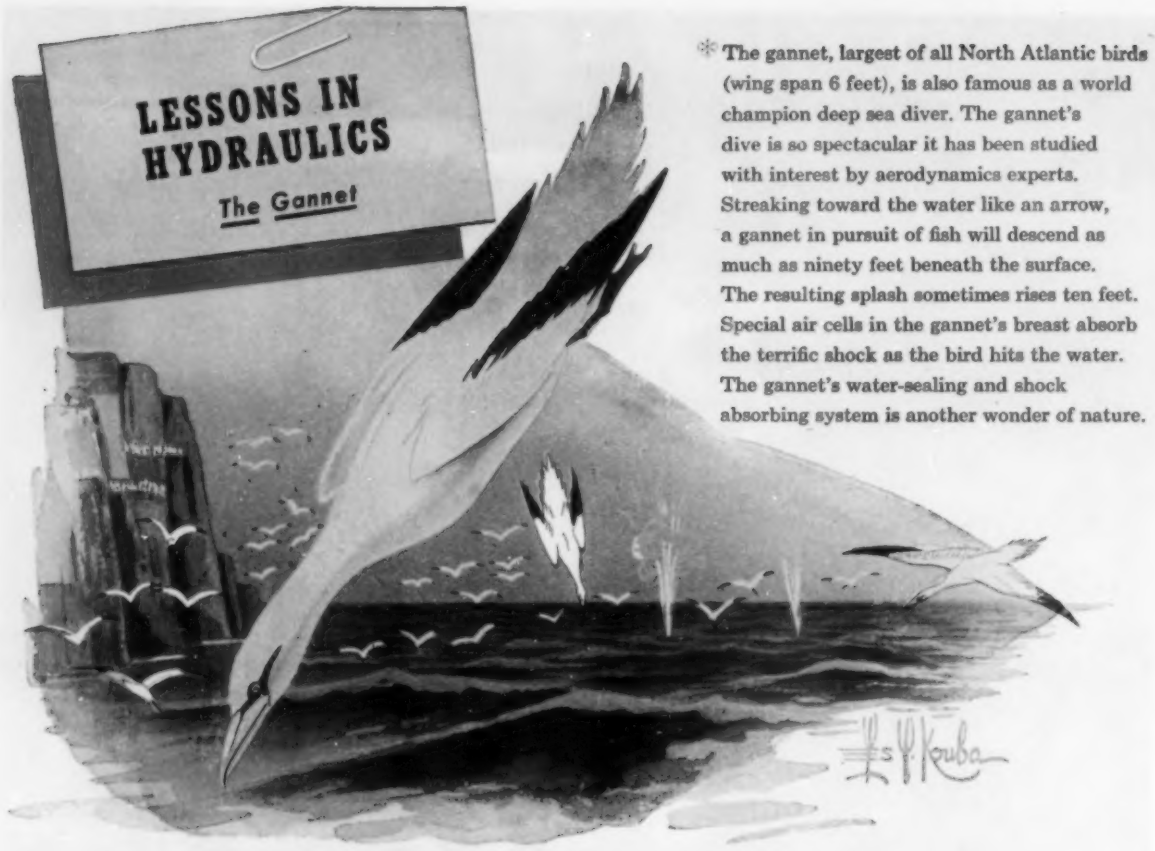


SHEET STRIP ROD WIRE

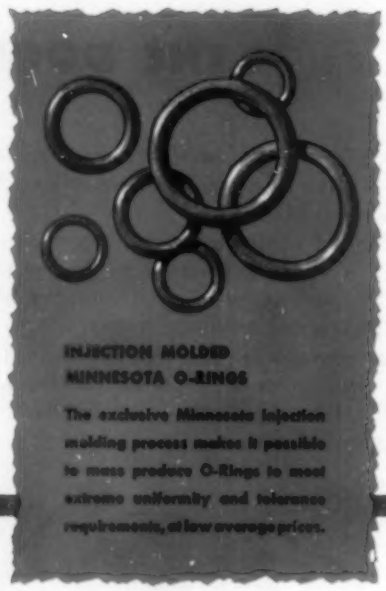
Free pocket-size Alloy Handbook. Your reference and guide to Alloy specifications. Write today.



* The gannet, largest of all North Atlantic birds (wing span 6 feet), is also famous as a world champion deep sea diver. The gannet's dive is so spectacular it has been studied with interest by aerodynamics experts. Streaking toward the water like an arrow, a gannet in pursuit of fish will descend as much as ninety feet beneath the surface. The resulting splash sometimes rises ten feet. Special air cells in the gannet's breast absorb the terrific shock as the bird hits the water. The gannet's water-sealing and shock absorbing system is another wonder of nature.

THE BIRD WITH SHOCK PROTECTION

Minnesota O-Rings are "doughnut shaped" packings used as shaft seals in air, gas or hydraulic systems. Every day, leading product engineers are proving the dependability and wide application of O-Rings by discovering new uses for these unique seals. Minnesota O-Rings are made from special compounds of natural or synthetic rubber to meet exacting product specifications for close tolerances and uniform quality. Hundreds of successful installations have been designed into such equipment as hydraulic rams and regulating valves . . . remote control mechanisms . . . air cylinders . . . water pumps . . . gasoline and steam engines. For prompt analysis and quotation on your next packing installation, send us your blueprints or specifications.



INJECTION MOLDED MINNESOTA O-RINGS

The exclusive Minnesota injection molding process makes it possible to mass produce O-Rings to meet extreme uniformity and tolerance requirements, at low average prices.

* *The many advantages and applications of injection molded O-Rings merit your investigation. Bulletin available on request.*

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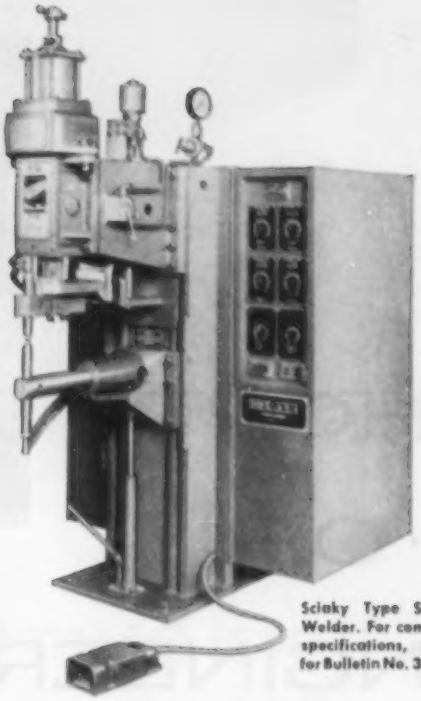
STANDARD WELDER ADAPTED FOR SPECIAL APPLICATIONS



Sciaky Type SPT 2 Welder. For complete specifications, write for Bulletin No. 306-1.

Two Standard Sciaky Three-Phase Welders Join 42 Parts in 4 Operations

A short time ago Casco Products Corporation, Bridgeport, Conn., consulted Sciaky about special equipment for resistance welding simulated wire wheels for automobiles.

Power limitations at Casco were further complicated by design requirements . . . 40 spokes of .430 stainless steel joined to retainer rings . . . accurate fit on the automobile wheel demanded precise alignment of welded assembly...production rate of 1200 per day...strength to withstand vibration and shock of wheel rotation.

Avoiding the expense of special machines, Sciaky adapted two standard type SPT 2 welders with special tooling for multiple gun operation. Only four operations were required to join the 42 parts of the assembly.

Sciaky patented Three-Phase operation readily satisfied existing power facilities where conventional single phase could not. Sciaky Three-Phase, also, provided precise control to maintain tolerances of setdown and alignment.

The strength of the spot welded assembly exceeded requirements, and Sciaky Three-Phase produced a smooth fillet at weld eliminating need for special metal finishing. Production requirements were satisfied.

Write for the complete story of Casco's use of Sciaky welders for this job. Ask for "Resistance Welding at Work", Volume 3, No. 9.

Largest Manufacturers of Electric Resistance Welding Machines in the World

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Engineering drafting room at Chance Vought Aircraft

SHORT OF ENGINEERS?

Photocopy Eliminates Unnecessary Drafting . . . Frees Your Trained Men for ENGINEERING

One good way to lick the shortage of engineers is to get more out of the trained men you now have. Often, that's as simple as this: give them better tools, lift some of the burden of routine work from their shoulders, free them for truly creative work.

For example, set up better, more efficient drafting room practices or faster reproduction methods. One of the most time-saving of these is the use of photocopying to eliminate unnecessary redrawing — when, for example, only minor design changes are called for.

This shortage of engineers — right now estimated at 60,000 — is expected to remain acute for several more years. The Engineers' Joint Council sees the annual crop of graduates falling 60% short of the need for at least the next three years.

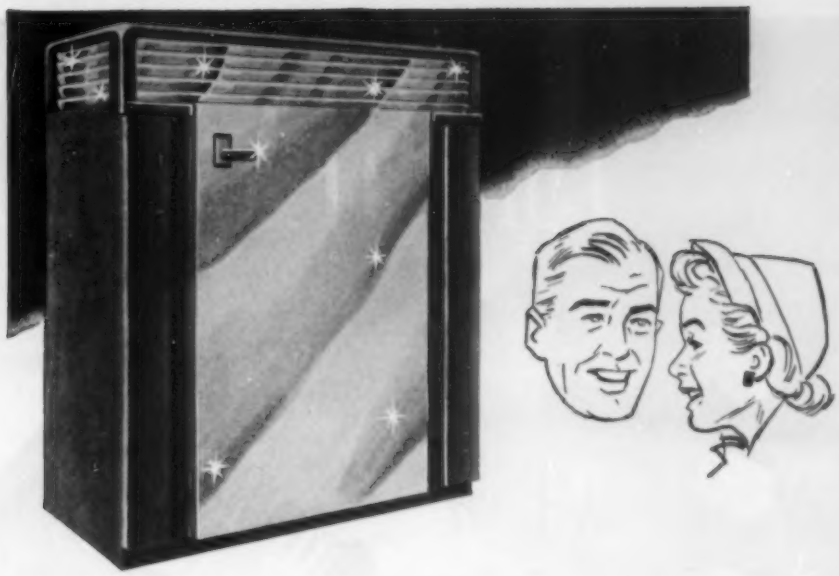
Have you examined *your* drafting room practices, your record reproduction methods, lately, in the light of this shortage? Are you getting the most from the trained men you now have?

Your Peerless distributor — a specialist in photocopying methods — will be glad to go over your procedures with you and offer his professional counsel on where you can make greater savings of time through the wider use of better photocopying methods. He has the long experience, the factory training, to be of real help to you. Why not call him today? If you are not sure of his name, write us and we'll put you in touch with him.

PEERLESS PHOTO PRODUCTS, INC.

Shoreham, Long Island, N. Y.

Manufacturers of Quality Photocopy Papers and Special-purpose Industrial Photocopy Equipment



ENDURO BRIGHTWORK . . .

gets them all talking SALES

People are favorably impressed by well-chosen ENDURO Stainless Steel brightwork.

It's an unmistakable sign of top quality in a manufactured product. It's a point to talk about as another reason for choosing your line.

And, there's no reason why your products shouldn't have this sales advantage *now*. You and your suppliers can fabricate ENDURO Stainless Steel on your present equipment with little or no change in procedures. There's no plating, painting or other finishing needed. As compared with forming, then cleaning, then plating, then polishing; cost is very attractive.

With ENDURO, you have brightwork that stays bright. It resists rust and corrosion, doesn't tarnish. It has no plating to chip, peel or flake. It's superbly easy to clean and to keep clean. It stays bright for the life of the product.

When your sales staff can point out to distributors and jobbers that your brightwork is genuine ENDURO Stainless Steel . . . when distributors can tell dealers . . . when dealers can tell their customers . . . and housewives can tell one another . . . then you've got them all talking sales! Republic will help you choose proper ENDURO Types and fabricating procedures. *Write:*

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Other Republic Products include Carbon and Alloy Steels—Pipe, Sheets, Strip, Plates, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

IMAGINATION

makes the difference

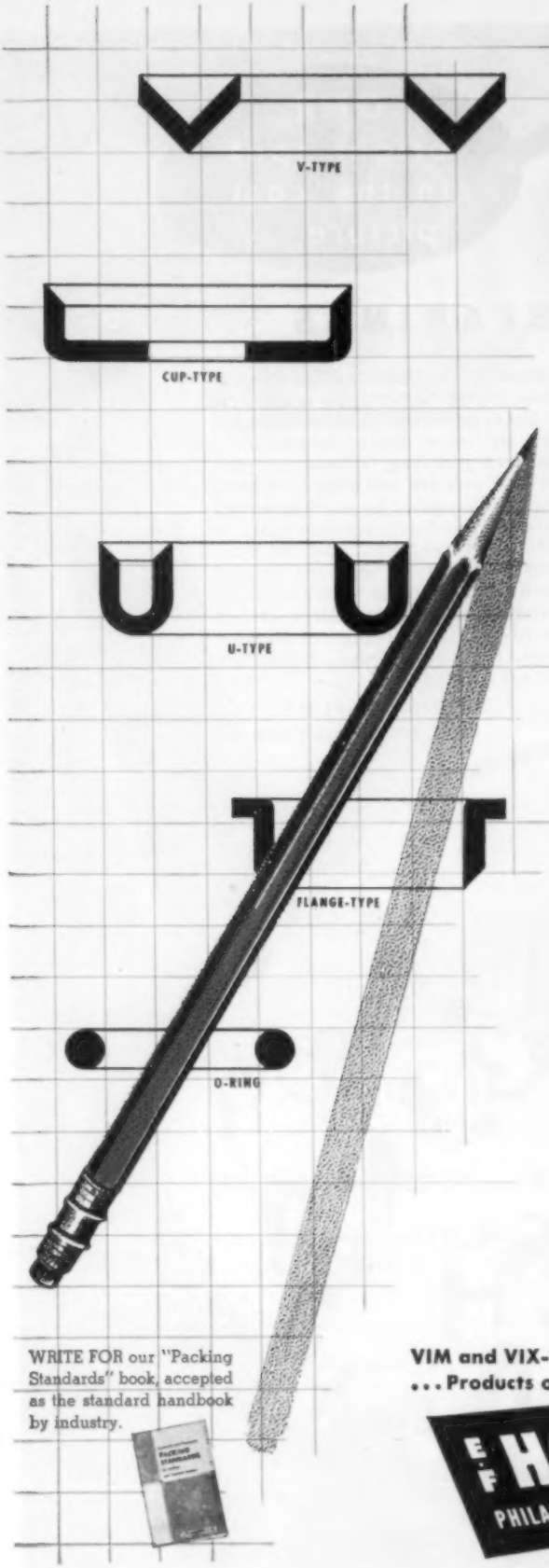
For many years, we at Accurate have talked about our skill, experience and know-how . . . but other springmakers are unquestionably skilled, some have even more experience and must have accumulated a lot of know-how. Yet, what makes it possible for Accurate to so often devise new and better ways to make better springs at lower cost?

A customer gave us the answer in a single word—*imagination.*

If you would like to do business with an organization that has imagination . . . plenty of skill, experience and know-how . . . will approach your problems without necessarily being too influenced by conventional methods . . . send an outline of your requirements. There's no obligation and it may well be your first step towards getting better springs at lower cost. Write today. ACCURATE SPRING MFG. CO., 3815 W. Lake Street, Chicago 24, Illinois.

Accurate Springs

Springs • Wireforms • Stampings



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LEATHER PACKINGS

cup, flange, U and V types—flat washers, discs and gaskets—for oil, air, water or gas applications—used for all pressures and for temperatures up to 200° F.

VIX-SYN SYNTHETIC
RUBBER PACKINGS

including homogeneous and fabricated packings, gaskets and adaptors—also O-rings and "Vim" leather back-up washers designed for use with them.

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HOUGHTON HAS THEM ALL!

WRITE FOR our "Packing Standards" book, accepted as the standard handbook by industry.

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. . . Products of

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Ready to give you on-the-job service . . .

PACKING AD #1-53

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bright spot
in the cost
picture . . .
JOHNSON BEARINGS
Labor costs, overhead and materials continue to rise. Yet . . . here is one item on which you can save money . . . Johnson Sleeve Bearings. They are low in first cost, economical in installation, and give long, satisfactory performance. Perhaps you are using more bearing than you need. Investigate Johnson Bearings. They are produced in industry's widest range of bearing metals and types: aluminum on steel, bronze on steel, babbitt on steel or bronze, powder metallurgy, cast bronze, cast aluminum alloy, sheet bronze and graphite inserts. Design or redesign to utilize the economies of Johnson Sleeve Bearings. Free engineering consultation is yours for the asking. Write.
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JOHNSON B BEARINGS
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Strength and . . . when you need Flexibility

The Strength of Steel, plus the Flexibility of Rubber, is built into WIRETEX. Designed specifically as a high-pressure conductor for use on hydraulically operated road, farm, materials handling, coal mining and oil machinery, dump trucks, busses, snow plows, lubrication and railroad equipment . . .

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Tough armor for a tractor's "works"

For rugged castings that house vital tractor transmissions, FORD looks to Lycoming for quality volume production.

Dirt "eats" at it . . . feet "stomp" on it . . . tensions "pull" at it . . . but the Ford tractor's sturdy transmission housing protects the "works" within. For these tough suits of armor cast by a *metallurgically controlled* process, FORD looks to the skilled hand of Lycoming.

Do *you* need quality castings in volume . . . or any other of the diversified services listed with our signature? Lycoming's wealth of creative engineering ability . . . 2½ million square feet of floor space . . . and 6,000-plus machine tools stand ready to serve you. *Whatever* your problem . . . *look to Lycoming!*

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For any hydraulic problem involving capacities up to 60 gpm and operating pressures up to 3000 psi, your one best answer for *continuous* peak performance is a PESCO Pressure Loaded PUMP.

In addition to the unmatched PESCO Pressure-Loaded principle which insures new pump efficiency throughout the long service life of the unit, PESCO brings another great advantage to your products. PESCO design and operating features permit use of smaller, more compact units for any specific installation and operating requirement.

In the final analysis, all advantages of PESCO equipment may be summed up in three phrases: (1) "*Continuous* peak efficiency"; (2) "Dependable performance"; and (3) "Lowest lifetime cost".

PESCO Hydraulic Engineering Service is available to you without obligation—to show the advantages of PESCO equipment as applied to your specific problem. Simply call or write the Home Office, Bedford, Ohio.

YOU CAN RELY ON PESCO FOR THESE ADVANTAGES

DEPENDABLE OPERATION
•
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•
AUTOMATIC ADJUSTMENT FOR WEAR
•
LESS UNIT SPACE REQUIRED
•
LOWEST LIFETIME COST

Call or write the Home Office, Bedford, Ohio for full information on these outstanding PESCO PRODUCTS

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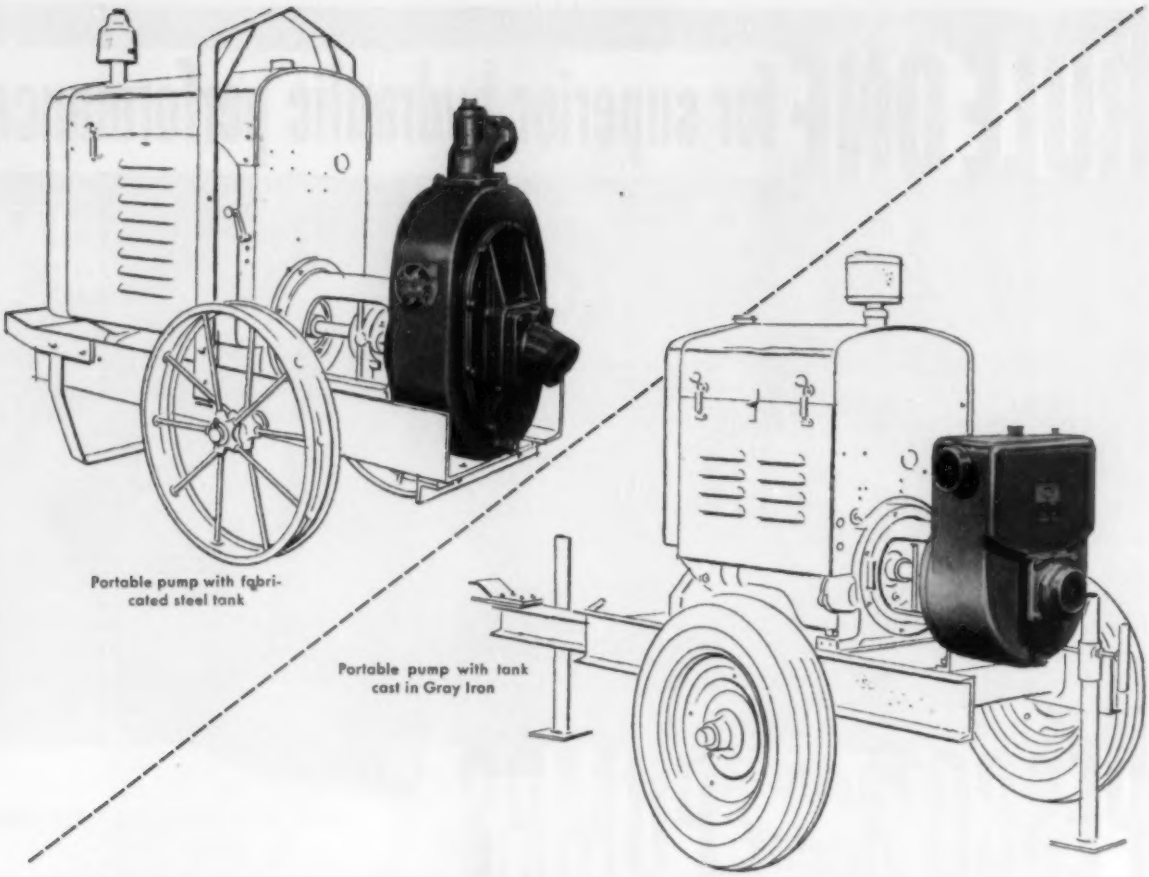

Portable pump with fabricated steel tank

Portable pump with tank cast in Gray Iron

Costs down 20%... efficiency up with GRAY IRON!

This Marlow portable self-priming centrifugal pump originally was made with a fabricated steel pump tank. In modernizing the unit the manufacturer redesigned the tank for production in Gray Iron, thus realizing a *20% saving in costs* . . . as well as substantially increased efficiency over the fabricated tank previously used.

This same type of cost-saving story may be told about some of your fabricated parts, if you take the time to consider the many advantages of the Gray Iron casting process. Write for technical information.

GRAY IRON CHARACTERISTICS INCLUDE:

CASTABILITY
STRENGTH
RIGIDITY
LOW NOTCH SENSITIVITY
WEAR RESISTANCE
HEAT RESISTANCE
CORROSION RESISTANCE
DURABILITY
VIBRATION ABSORPTION
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MAKE IT *BETTER*...WITH GRAY IRON

75% of all cast metal products are Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.

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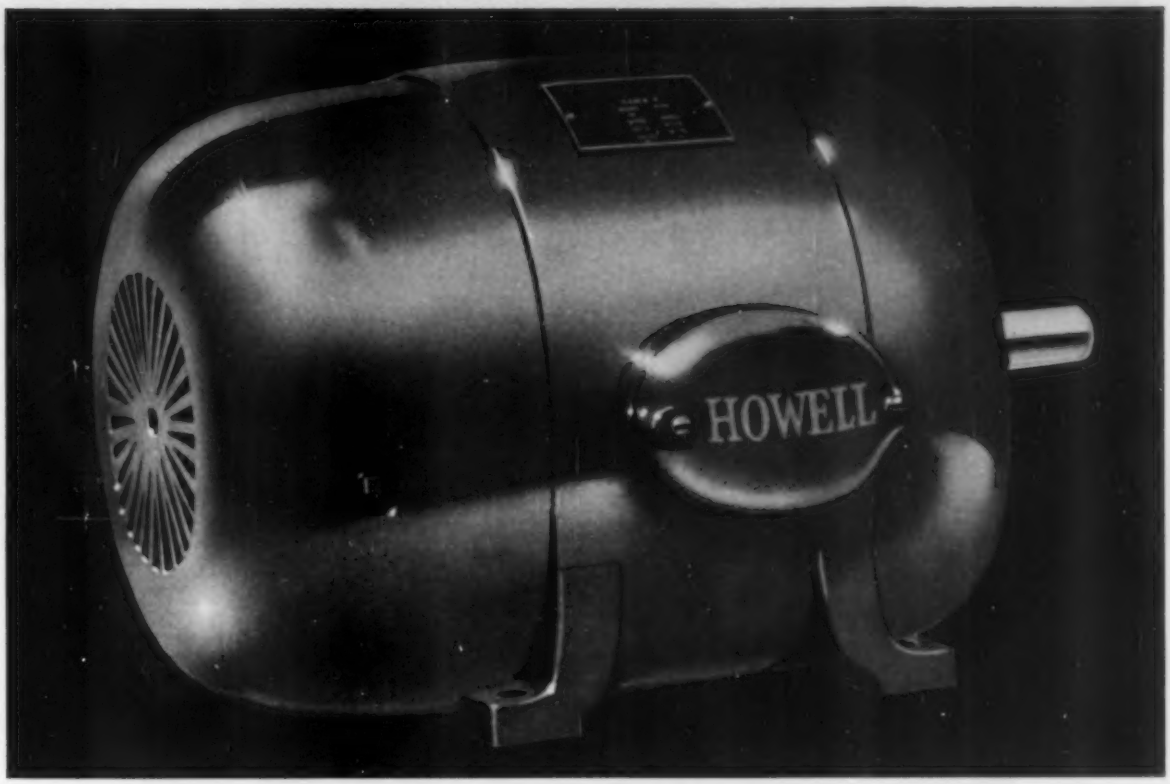
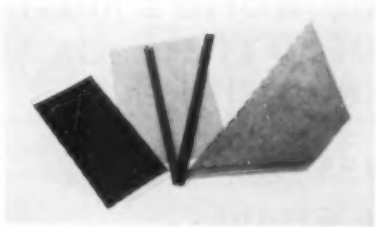


HOWELL FAN-COOLED MOTORS

Totally enclosed, protected against dust, fumes and moisture—the best looking motors your money can buy!



More and better insulation. Each slot cell has seven different pieces of insulation. Top and bottom coils and phase groups are insulated. Howell insulation is unsurpassed in quality.

Improved coil varnish. Type K stators are thoroughly impregnated twice with a phenolic, resin base varnish, and twice baked for unusual protection against moisture, dust, oil, weak acids and mild alkalies.

Howell Type K Motors outperform and outlast any open-type motor. Totally enclosed, all working parts are protected against the destructive action of dust, dirt, fumes and moisture. The fan-cooling prevents motor overheating.

The all-steel, streamlined housing conforms to the most modern trends in machine-tool design and factory layout.

Howell Type K Motors are available in all electrical types, from 1½ to 300 hp. at 1800 rpm., with vertical or horizontal mounting.

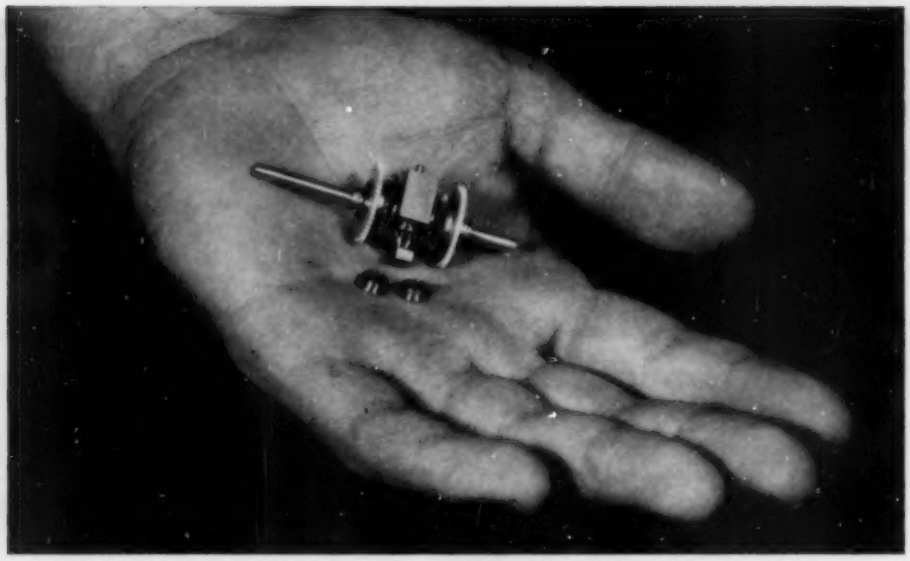
For more complete information on Howell's Type K Motors, contact the Howell man in your area, or write the factory for Bulletin K-2.

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915



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Tiny, but mighty . . . Ford Instrument Company's ⅛" single spider gear type differential with Zerol gears and MICRO bearings makes for low friction with 'back-lash' tolerances such that the most rigid requirements of computer and control systems are satisfied. Differentials of this kind are used by Ford Instrument Company in systems for all phases of designs and production of Navigation, Gunfire and Guided Missile control and/or positioning devices.

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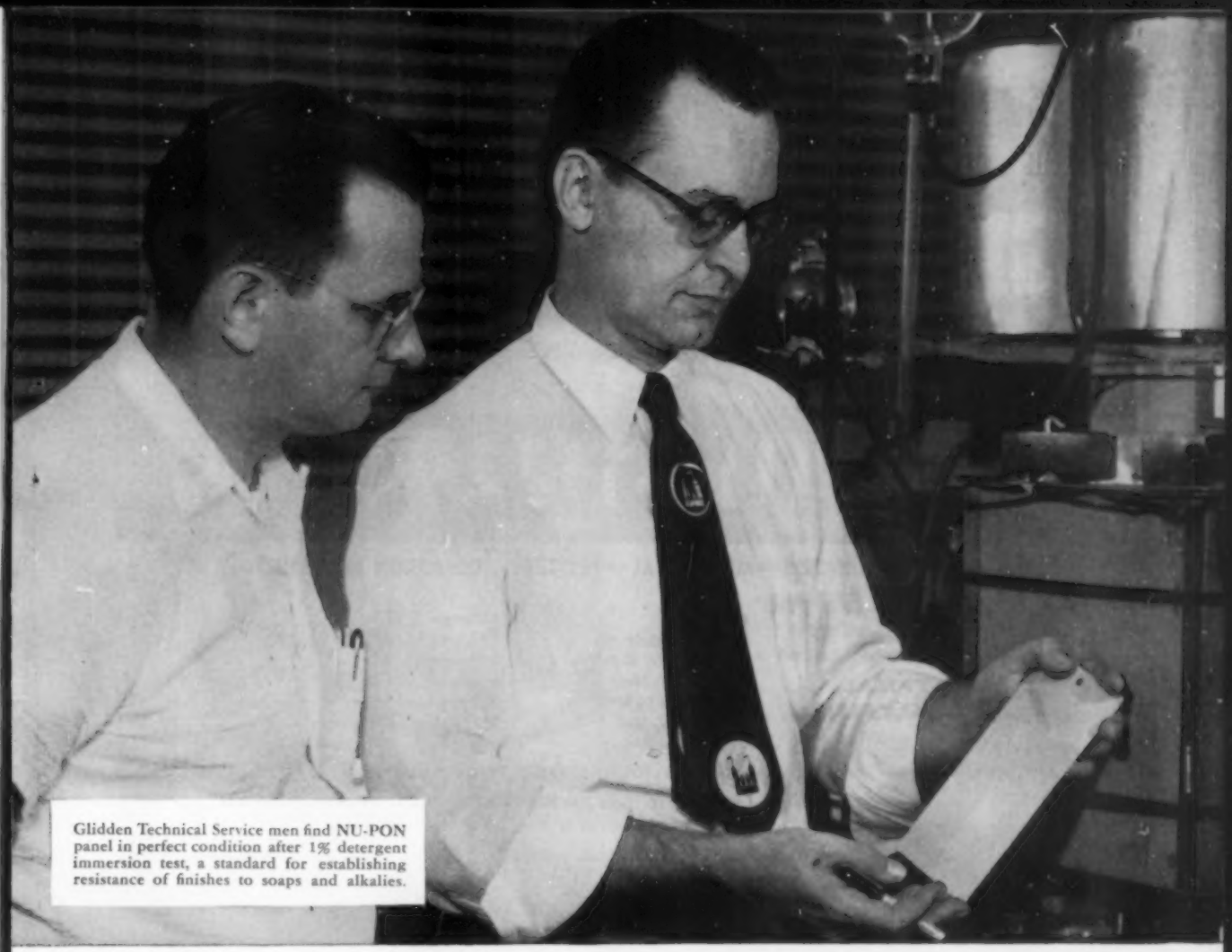

Glidden Technical Service men find NU-PON panel in perfect condition after 1% detergent immersion test, a standard for establishing resistance of finishes to soaps and alkalies.

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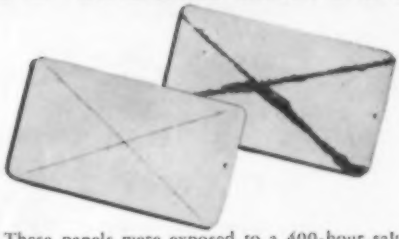
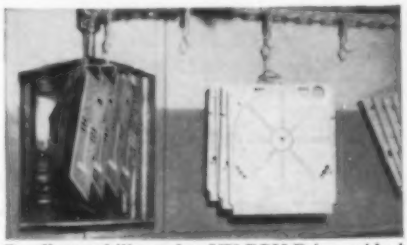


These panels were exposed to a 400-hour salt spray test together. The thin film of NU-PON Primer on the panel at the left has not eroded while the modified alkyd film at the right has pitted and flaked off.



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Carbon ½ Moly	7 Chrome ½ Moly
½ Chrome ½ Moly	8 Chrome ½ Moly
1 Chrome ½ Moly	8 Chrome 1 Moly
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2 Chrome ½ Moly	3½ Nickel 7½ Nickel
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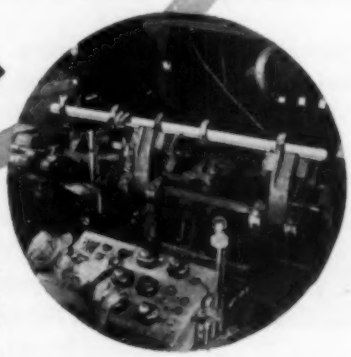

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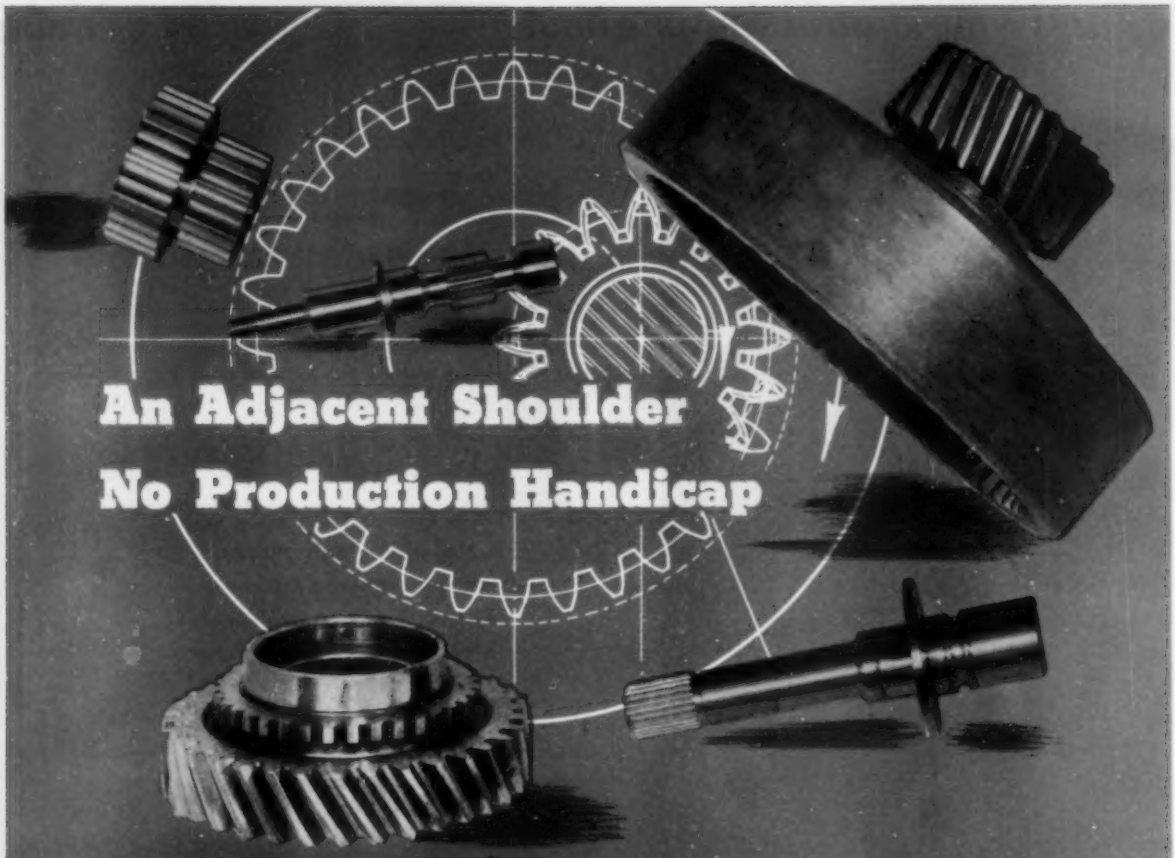

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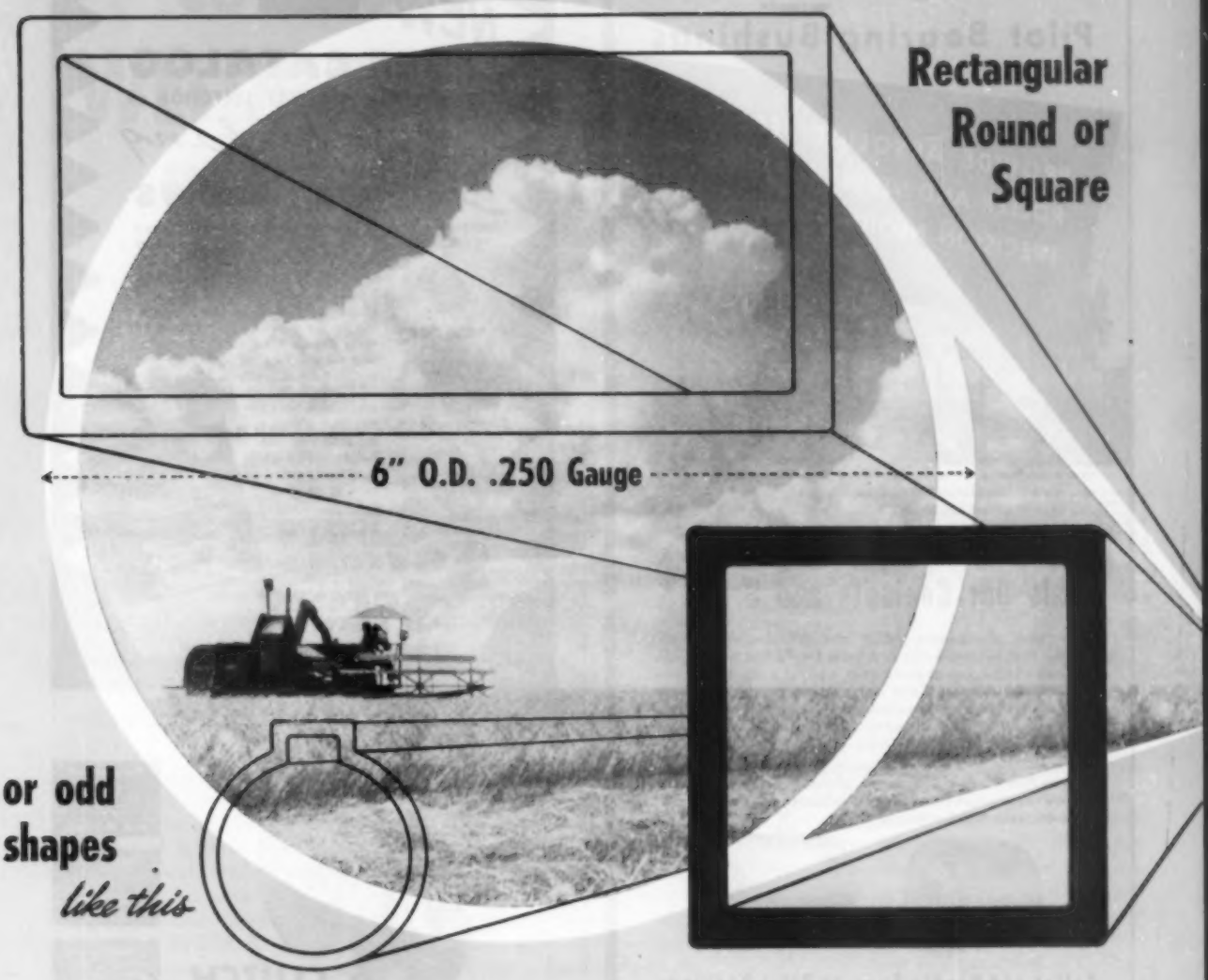

is broadening farming horizons . . . .

Population growth figures show that within a few years every five acres of farmland will have to produce as much food as six acres do today. To meet this unprecedented challenge, new ideas, methods, materials and machinery will be exploited to the nth degree. Maybe now is the time to take a long, hard look at your products with these questions in mind: Can they be made better . . . faster . . . cheaper? Could Van Huffel Cold Formed Tubing be substituted for heavier, more costly materials now being used? We think we can answer that last question with hundreds of case histories and would welcome the opportunity of showing how you, too, can broaden your and farming's horizons.

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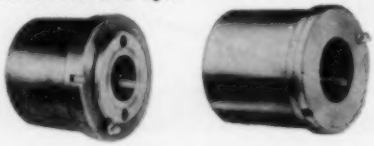

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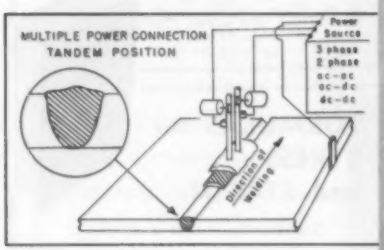

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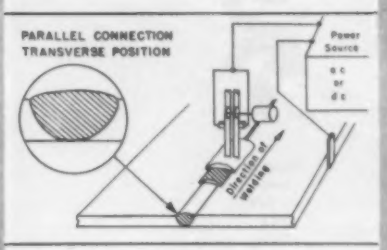

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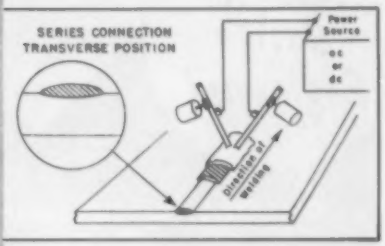

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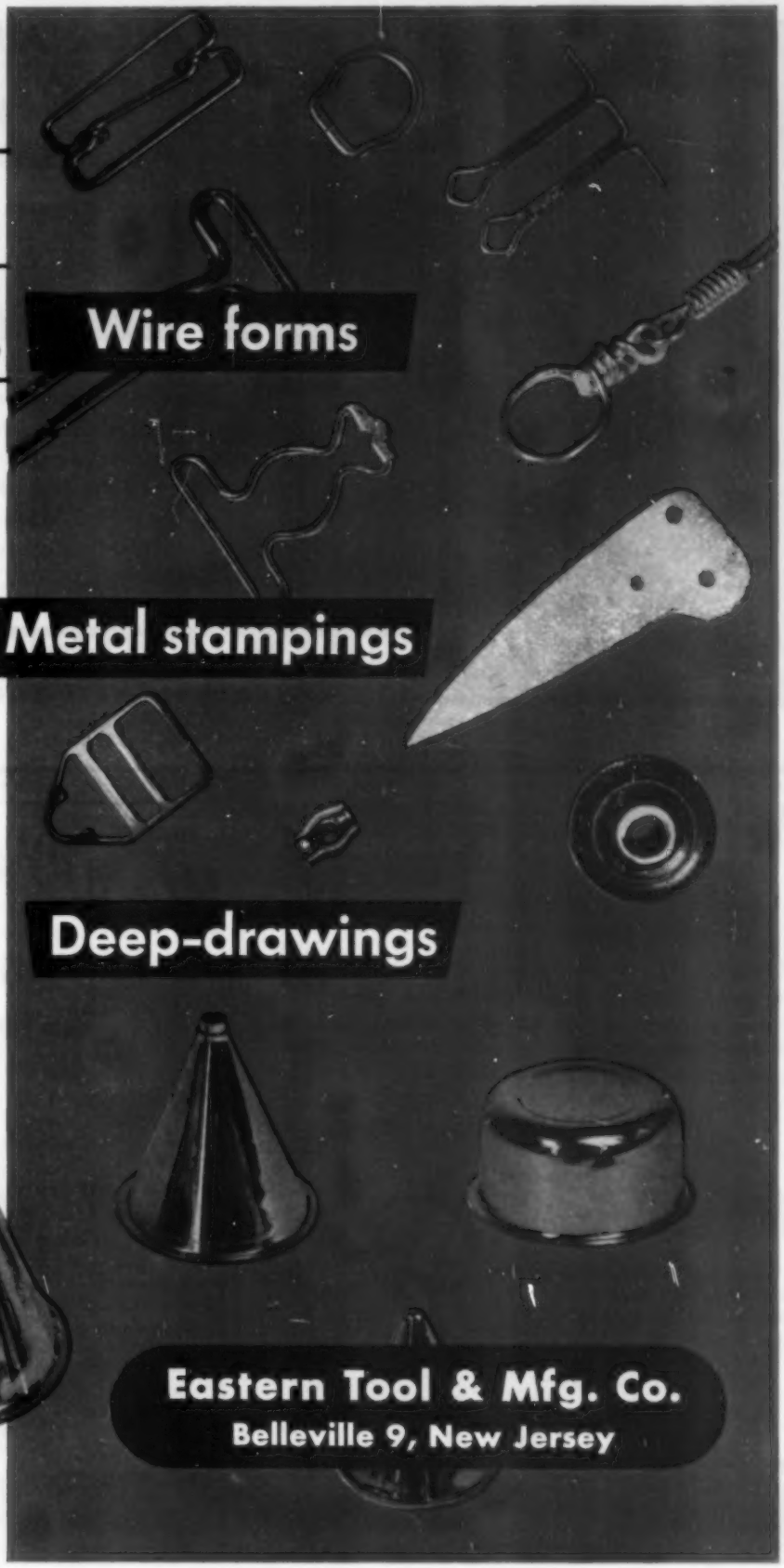

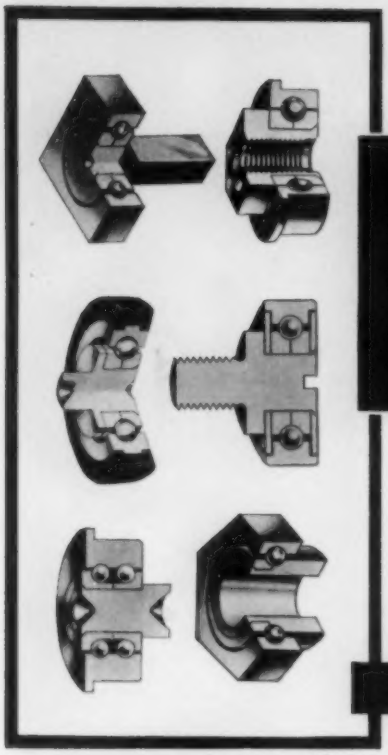

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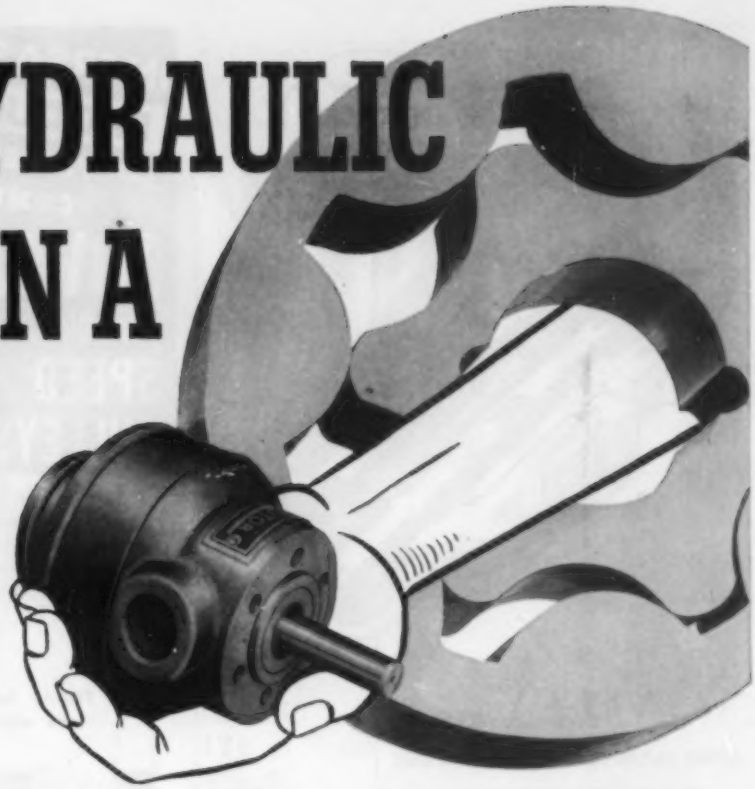

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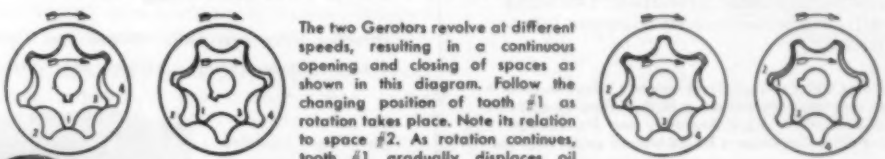

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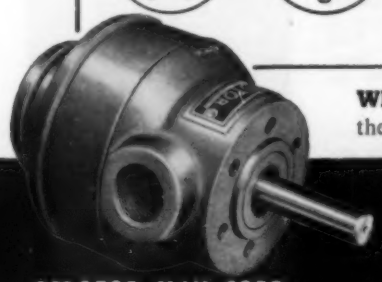

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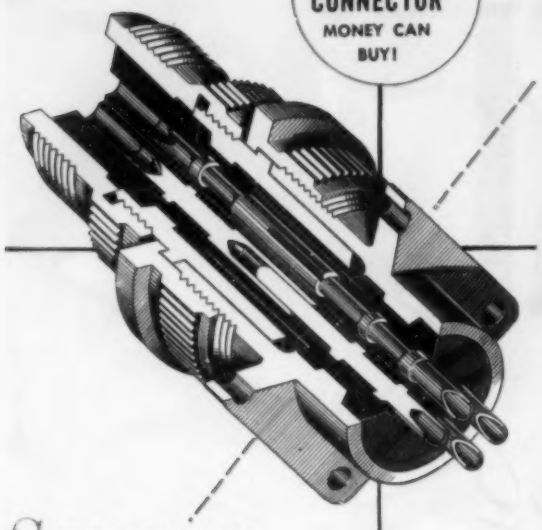

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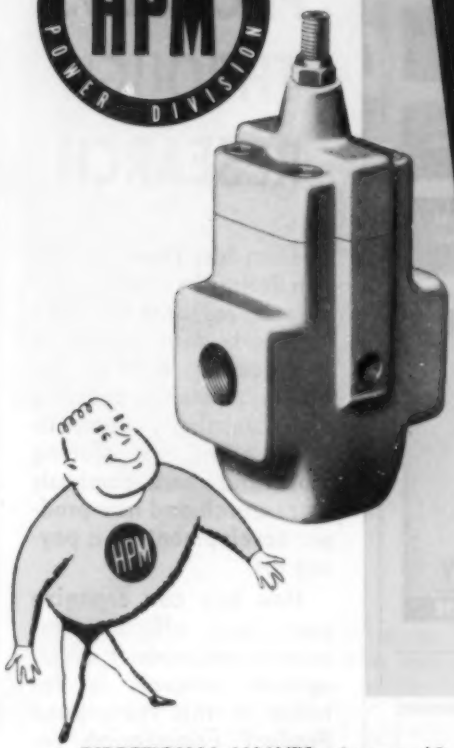

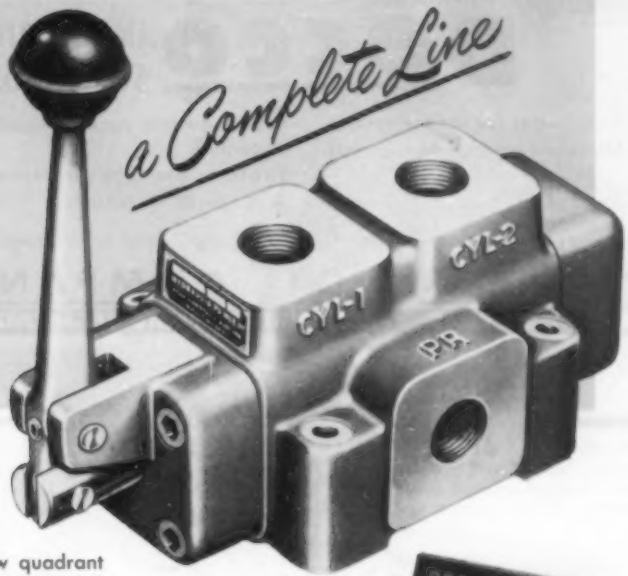

DIRECTIONAL VALVES—4-way and 2-way threaded valves, ¼" to 1½" in size for 2000 P.S.I. service • Manual, cam, foot, solenoid, oil and air pilot operation • Six spool styles • Stem, knob, lever and a new quadrant type control • Same models, types of operation and sizes also available with flange connections for 3000 P.S.I. • An equally complete line of gasket mounted valves, ½" to 4", 2000 and 3000 P.S.I. • Also rotary pilot valves • 3175 valve models with modern, improved styling for a maximum of service.

FUNCTIONAL VALVES—Relief, sequence, unloading, pressure reducing, counter-balance, flow control and check valves • Threaded connections, ¼" to 1½" sizes for 2000 P.S.I. • Flanged connections, ½" to 2½" sizes for 3000 P.S.I. • Gasket mounted, ½" to 2½" for 2000 and 3000 P.S.I. • Smooth, balanced control • Minimum pressure differential required for operation.

Write for the new H-P-M Catalogs covering Valves best suited to your requirements.

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2000 P.S.I. Threaded

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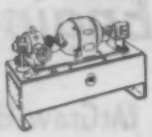
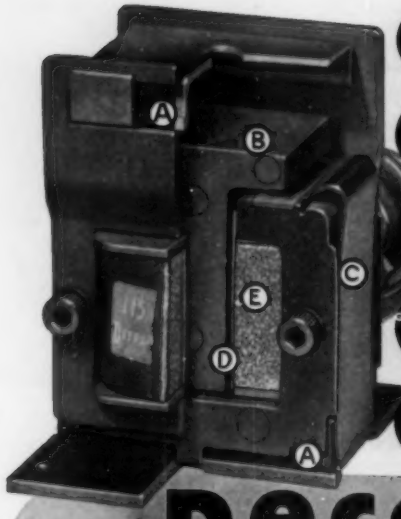


CYLINDERS

PUMPS & MOTORS

You know what you're buying when you specify HPM



(A) Shock-absorbing bumpers cushion stroke, assure longer service life.

(B) Silicon steel laminations give high efficiency.

(C) Tempered steel spring absorbs vibration — holds assembly firmly in alignment.

(D) Hardened beryllium-copper plunger guide reduces friction and wear.

(E) Heavy Formvar insulated magnet wire on high flow point molded nylon bobbin.

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Shock mounted to reduce self-destruction.
Designed to meet J. I. C. specifications.
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Stroke to one inch maximum.
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Bulletins 101 and 161 detail Federal's complete stamping service. Write for them. Better yet—send us a print of the stamping you want fabricated and the quantity needed. We will return, promptly, a quotation for the highest quality stampings at the lowest possible cost.

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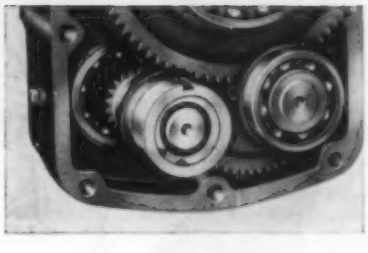

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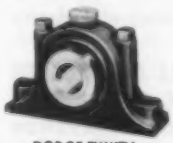

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FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, CHICAGO THRIFT-ETCHING CORPORATION, 1555 N. SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS

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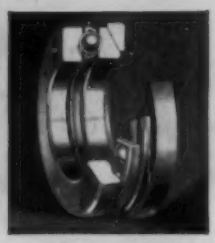

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SPECIAL BEARINGS • Facilities for sizes up to 38" O.D. Counsel that brings you the expert technical aid that has licked many of industry's toughest bearing application problems.

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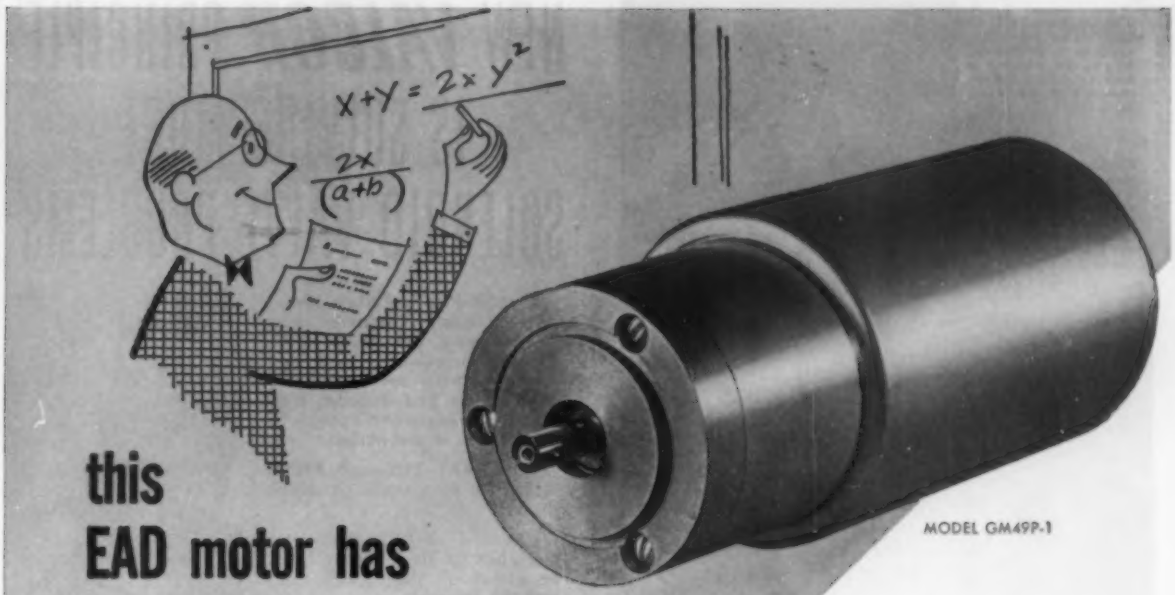
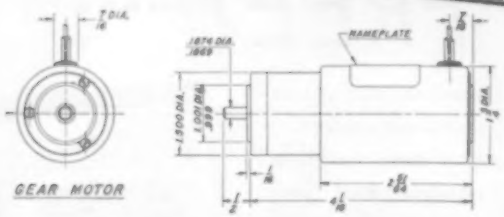


MODEL GM49P-1

this EAD motor has a "head" for torque problems



SPECIFICATIONS FOR MODEL GM49P-1

400 Cycle Capacitor Run Induction Gear Motor

115 Volts • 400 Cycles • 1 Phase • 0.5 Amps.
Full Load Torque: 100 Oz.-In.
Starting Torque: Over 100 Oz.-In.
Gear Head Lubricated per Mil-G-3278
22 R.P.M. • 314 to 1 Gear Ratio • Reversible Rotation
Intermittent Duty: 15 Minutes on, 15 Minutes off
Ambient Temperature: −55° to +74° C
Altitude: to 50,000 Ft.

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- Automatic Pilot
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A precision gear head combined with a miniature motor gives you the answer to high torque at low speed. The motor can be 60 cycle, 400 cycle or variable frequency—in single, two or three phase—with non-cooled or self-cooled frame types. The gear head is arranged to provide the output speed you require, with standard timing ratios of 60, 3600 or 8000 to 1 possible. High output torques, to drive, actuate or control, in confined areas, make this line of tiny gear motors ideal for a wide variety of applications on the ground and in the air.

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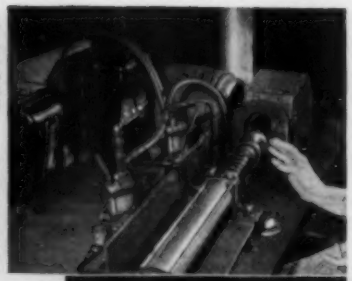
If your problem involves rotating electrical equipment, bring it to EAD. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.

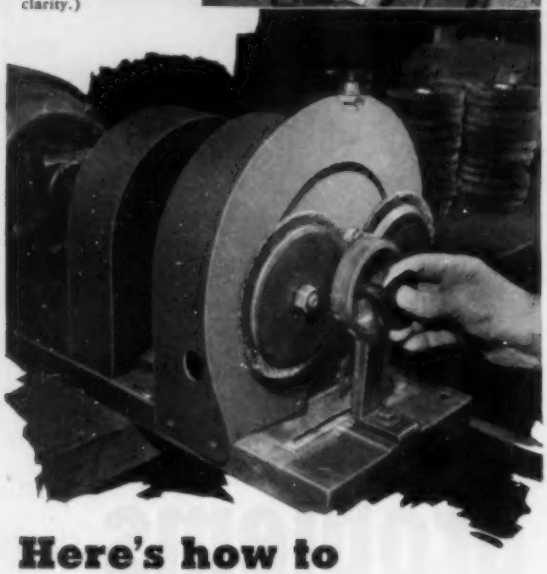
EAD **EASTERN AIR DEVICES, INC.**

15 WASHINGTON ST., DOVER, NEW HAMPSHIRE

The rubber base of each valve is roughened by a Pittsburgh brush to secure a better bond when vulcanizing the valve to a tube.



Pittsburgh brushes remove excess rubber which spills onto valve cap thread during vulcanizing operation. (Guard housing has been removed for clarity.)



Here's how to brush rubber

A. Schrader's Son, Brooklyn, New York, uses Pittsburgh brushes in the production of tire valves for leading tire manufacturers. In one operation, two brushes remove the excess rubber which flows around the valve threads during the vulcanizing process—750 valves per hour are cleaned in this manner!

Another Pittsburgh brush on a buffing machine roughens the rubber base of the valves to secure a better bond when vulcanizing the valve to a tube. In this operation, the Pittsburgh brush was chosen because it outlasts competitive makes.

WRITE TODAY for your free copy of our new booklet that shows thru actual case histories, how Pittsburgh can help cut *your* brushing costs. Address: Pittsburgh Plate Glass Company, *Brush Div.*, Dept. W-6, 3221 Frederick Ave., Baltimore 29, Md.

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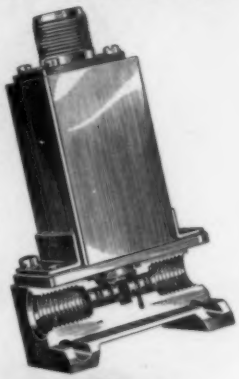
NEW *VALCOR* PRINCIPLE IS SOLVING MORE SOLENOID VALVE PROBLEMS



•**Valcor Floating Shear Seal:** Simple design eliminates need for precision fits. Seals 100% in both directions . . . and seal improves with use because of self-lapping. Self-cleaning, cannot clog because of exclusive floating shear seal action.

• **Straight-Through Flow:** Absolute minimum pressure drop.

• **Sealed-in-Coil:** Never an electrical failure reported. Built to withstand shock, vibration, and the elements.

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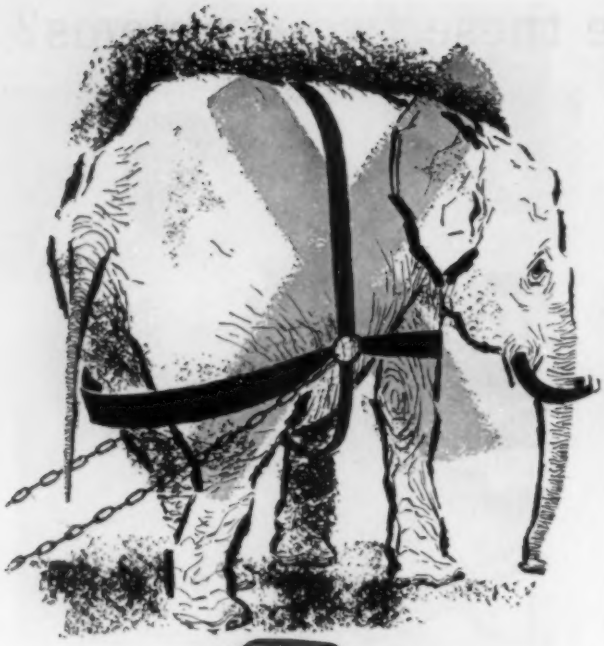
Electric Temperature Control and Detection Devices

SENSITIVE . . . but only to heat



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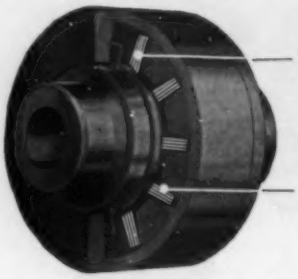
HERE'S WHY

KUSHION-TORQ

LENGTHENS EQUIPMENT LIFE



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Tapered slots move point of driving contact inward as loads increase to automatically stiffen cantilevers.

These Brown Coupling features mean equipment is shock and load protected - - - coupling failure is reduced - - - misalignment is corrected - - - radial and torsional vibration are dampened - - - both drive and driven units last longer.

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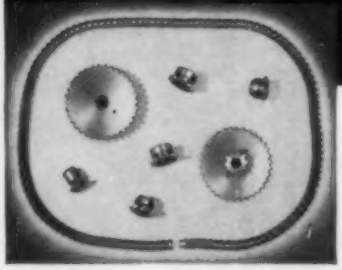
Rugged Winzeler Sprockets Help Drive the B.V.I. Sander



Winzeler Ladder Chain Stamped Sprockets bring smooth, dependable performance, long life and *low cost* to the excellent Burgess Belt Sander. Built for toughest sanding jobs, the BVI uses only the sturdiest components.

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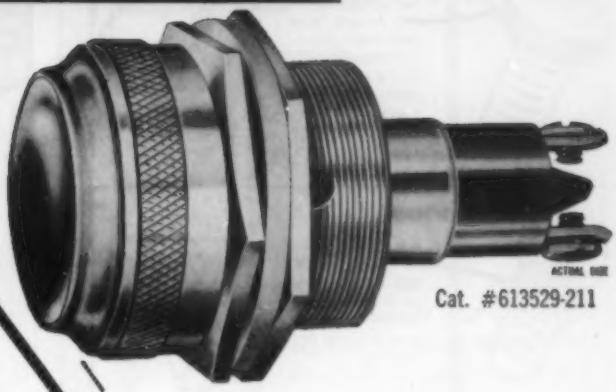
DIALCO



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THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

or

this LITTLE one

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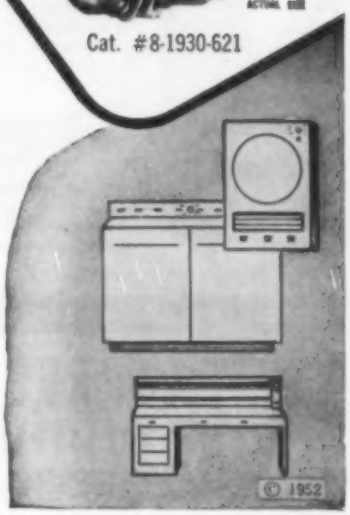

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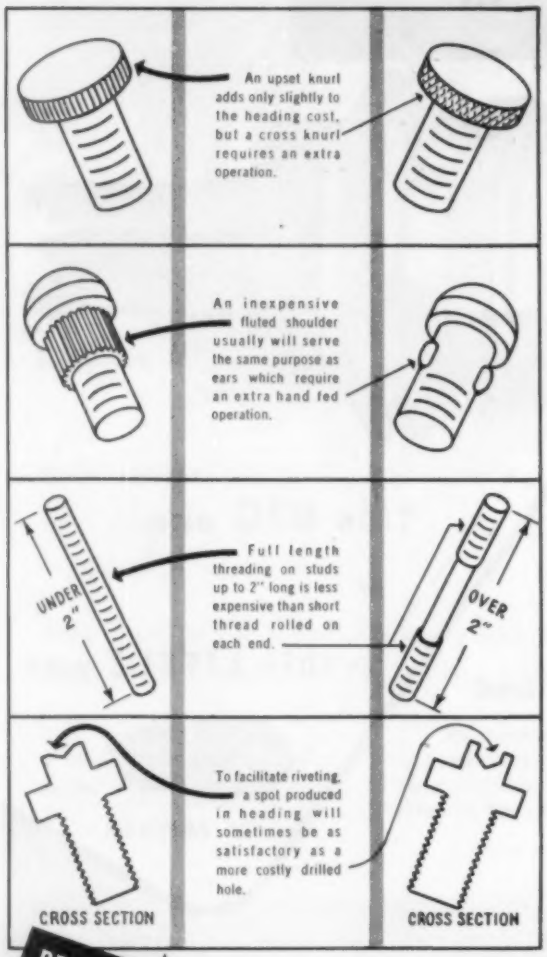
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An inexpensive fluted shoulder usually will serve the same purpose as ears which require an extra hand fed operation.
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CROSS SECTION

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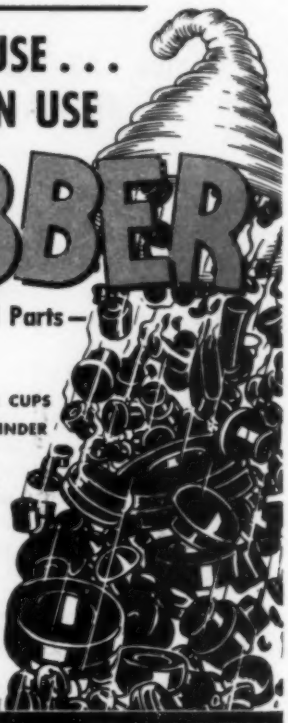

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Screw body continuous threaded, cross-drilled, and rifle-drilled for oil passages.

Base machined for socket-head installation and adjustment. All measurements held to specifications.

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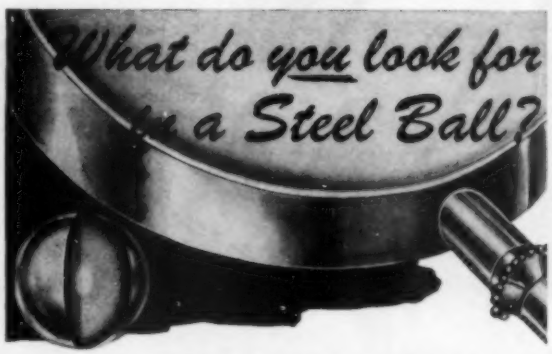

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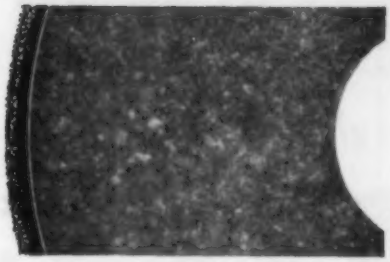
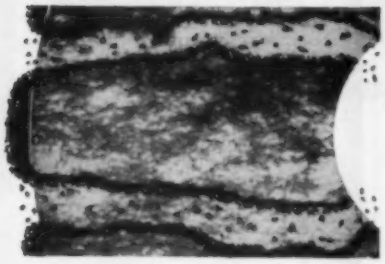
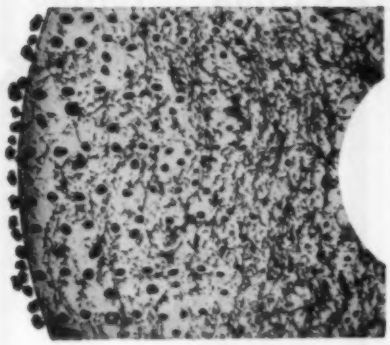
How MICRO-KLEAN compares with other cartridge filters



Compare MICRO-KLEAN with FILTERS WITH THE SAME DENSITY THROUGHOUT. The filter media density is the same on the pressure and discharge surfaces of the element; therefore, dirt accumulation is largely on the outside surface, choking the cartridge ("plastering") and reducing the effective filter life.



Compare MICRO-KLEAN with FILTERS WITH HAPHAZARD DISTRIBUTION OF FILTER MEDIA. Uneven haphazard media density permits fluid to find channels through the filter, and pass solids larger than the minimum filter spacing.



Now Look at the advantages offered by MICRO-KLEAN. See how the fibre density increases toward the discharge side of the MICRO-KLEAN filter cartridge? In effect, every Cuno MICRO-KLEAN cartridge is an infinite multiplicity of screens, ranging from relatively coarse on the outside down to 10 microns in the center. Because of MICRO-KLEAN's graduated density in depth, particles are entrapped within the entire depth of the filter element, giving the cartridge a much longer effective life. Standard cartridge size is 9¾" long by 2¾" O. D., in densities of 10, 25 and 50 microns.

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M.3.C

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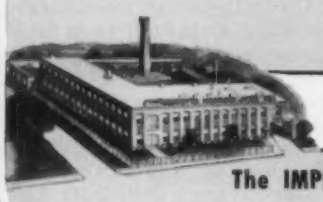

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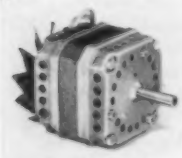

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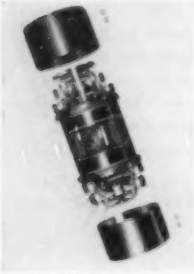

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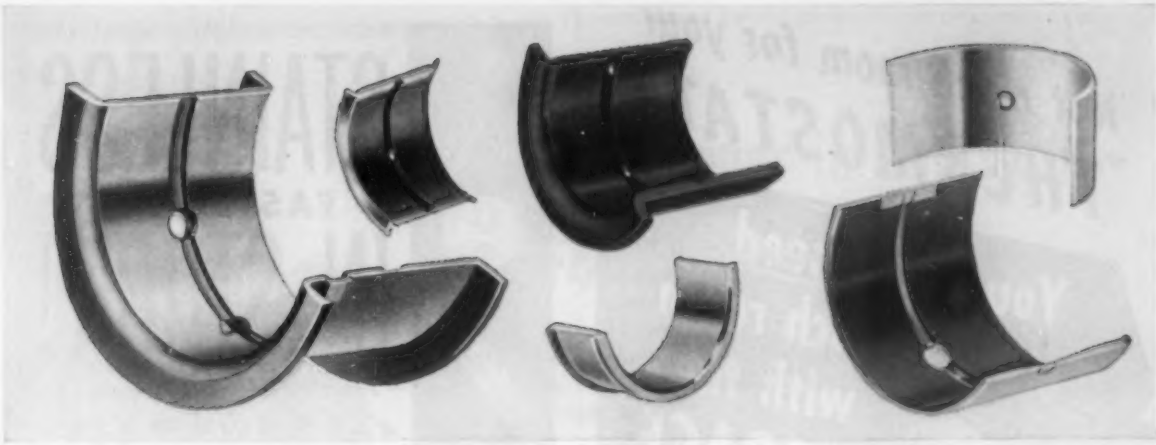

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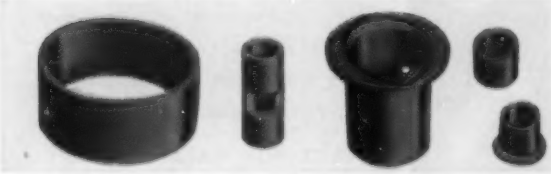

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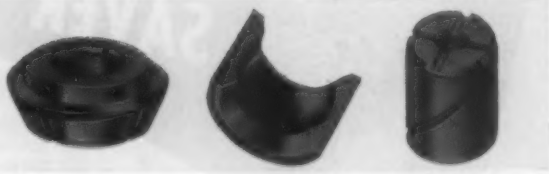

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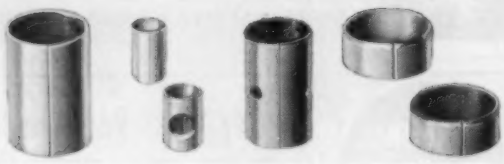

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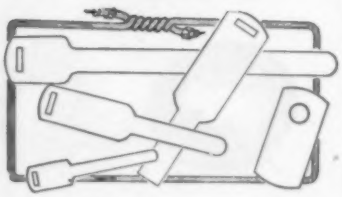

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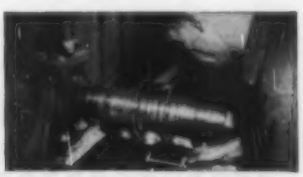

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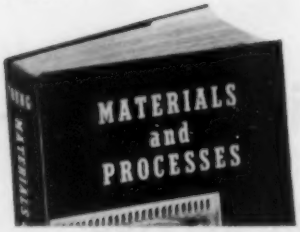

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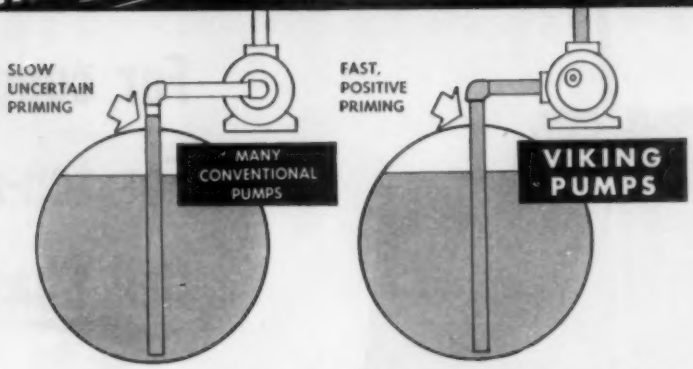

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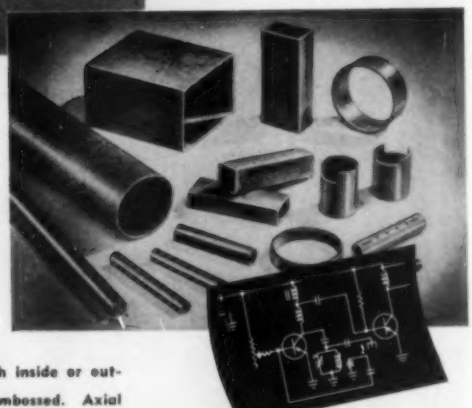

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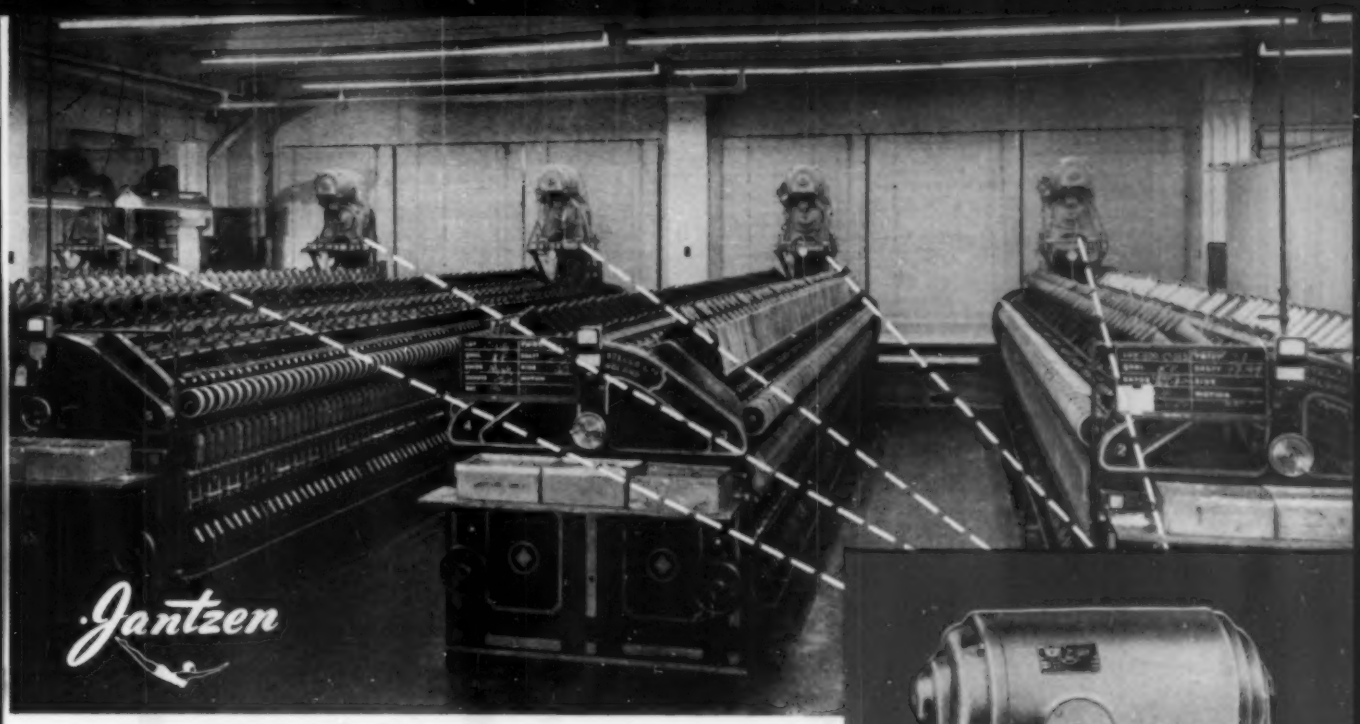

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adds dependable Timing Control *to your machines*

5200 Series Time Switch

Designed for heavy duty, built-in service on a wide variety of machines and appliances, such as baking, drying, plating, and washing machines. Standard equipment on many nationally known devices. Supplied either to make or break the circuit.

Electrical data: UL approved. 20-amp., 125 volt, 1 H.P.; or 10-amp., 250 volt, A. C. only. Through-panel mounting.

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An economical, durable Mark-Time unit designed especially for use on various domestic and industrial appliances. Available to make or break the circuit.

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Both units may be supplied with HOLD feature — with knob at HOLD position, current is held ON, but timing mechanism does not operate until knob is turned manually to a time period.

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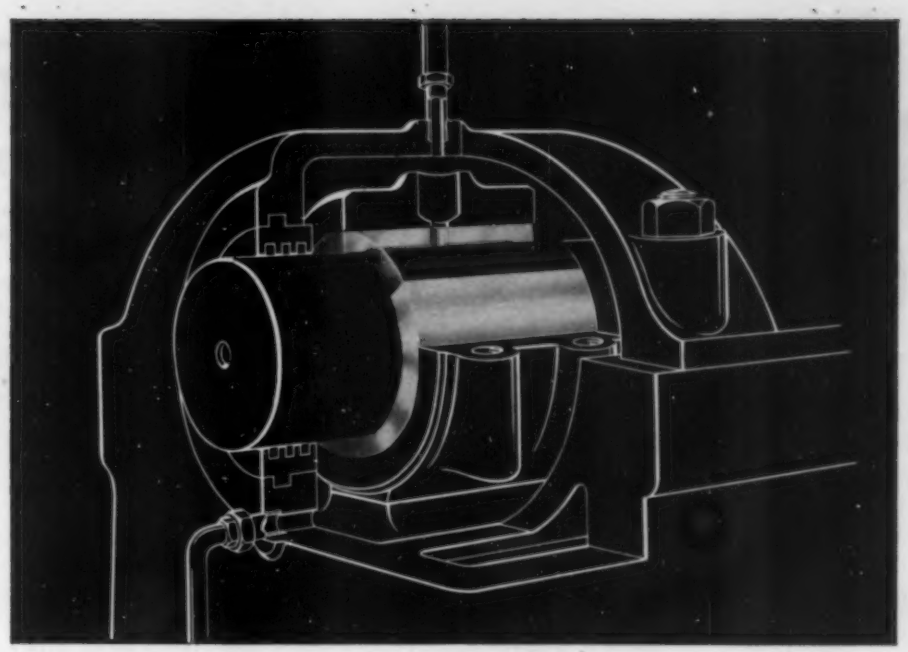

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The high cost of labor and of raw materials place on the shoulders of the Engineer and the Production Executive even heavier burdens than in the past. The sleeve bearing offers ways to reduce the cost of a design, simpler designs, easier to produce —designs that lend themselves readily to economical production.

The sleeve bearing is lower in initial cost than any other type of bearing. If your design is using bearings of any type other than the sleeve bearing the chances are very great that a change to the sleeve bearing will show you not only reduced initial cost but reduced over-all cost also, and this reduced cost accompanied by the smooth silent operation that only a sleeve bearing can give. The cast bronze sleeve bearing is the most adaptable of all sleeve bearings since it can be supplied in many forms from the most simple to exceedingly intricate.

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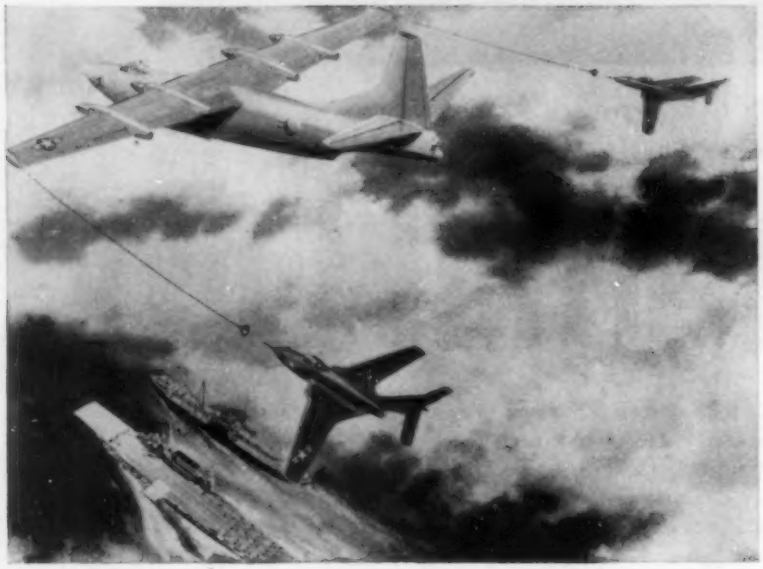
Precision Investment Castings help make possible *FLIGHT REFUELING*



The first crude attempts at refueling airplanes in flight were made about thirty years ago. Today, the procedure is completely routine and reliable beyond question.

Flight Refueling Inc., Danbury, Conn., manufacture the probe and drogue system which has now reached a high degree of perfection.

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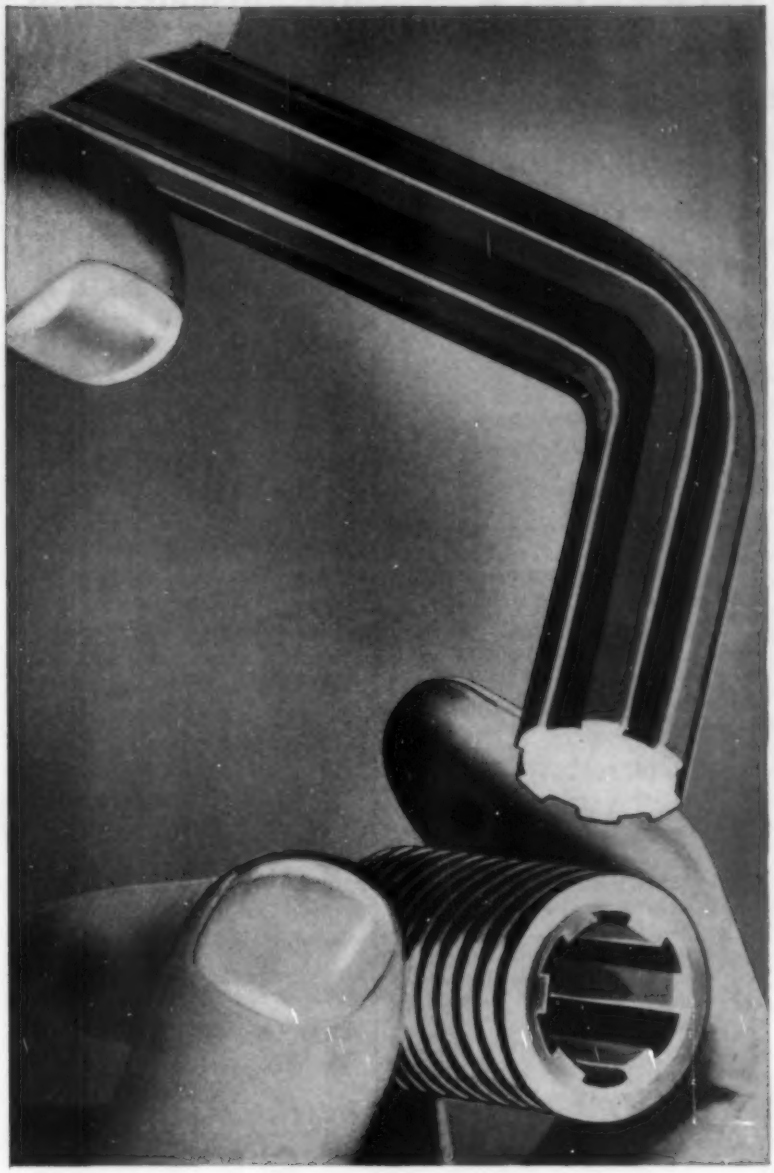
give far greater *HOLDING POWER*



The splining principle is recognized by design engineers as the most effective means of transmitting rotary power. That's why it's used in propeller hubs, drive shafts and automobile axles. In Bristol's Multiple-Spline Socket Set Screws, this design results in strength and holding power unequalled by any other screw.

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A.3.6

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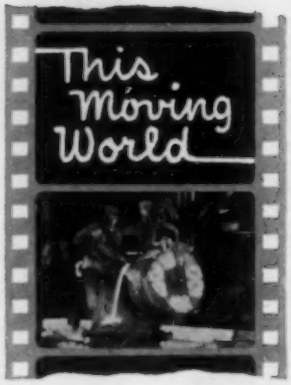
Send for "Malleable Iron Facts" useful information on Malleable properties and uses.



Schedule a showing of the Malleable Founders' Society Technicolor sound film, "This Moving World". The story of Malleable Iron — how it is made, tested and used. Available on request to groups of production men, engineers, students or others.

Ask your malleable castings supplier or write to the Malleable Founders' Society, Union Commerce Building, Cleveland 14, Ohio

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Strain Gage Transducers for Measurement and Control

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Numerous helpful diagrams and photographs . . . Copies available at 35 cents each.

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Product Engineering

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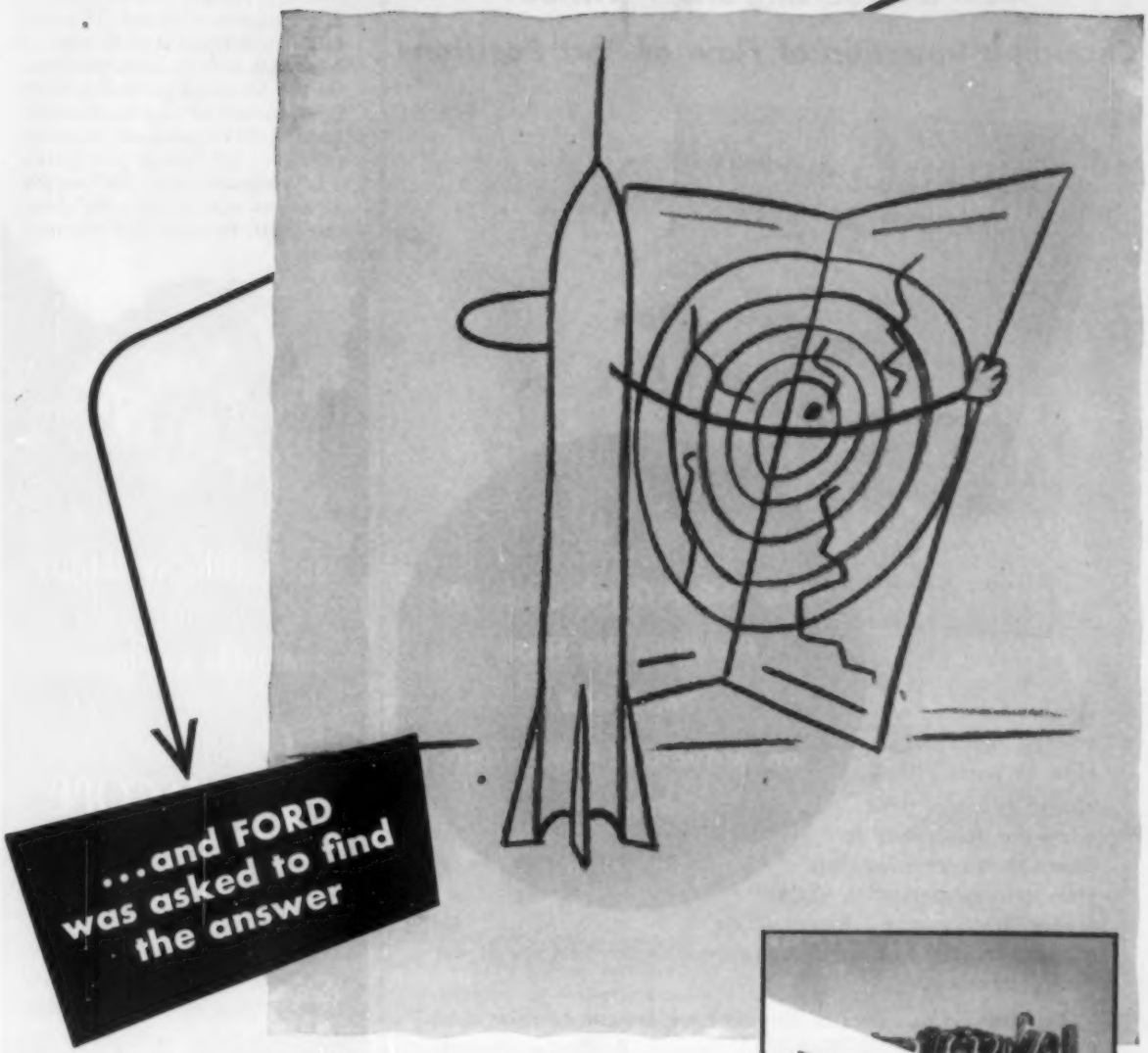
HOW TO TEACH A MISSILE
to read a map



Zwish! And off goes a missile. But where? And how to stay on the right track? And how to *find* the target? That's the problem Ford Instrument is helping to solve.

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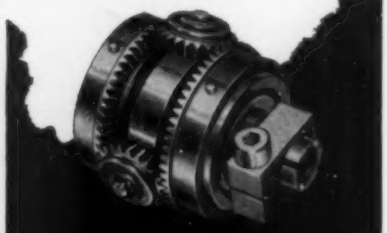

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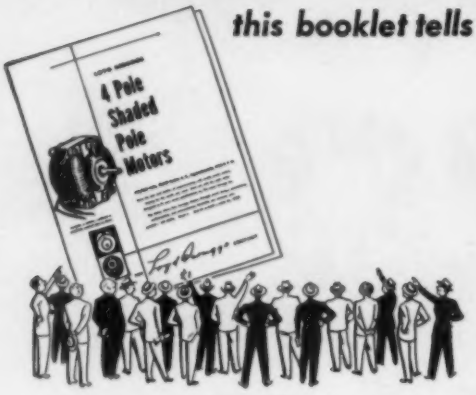
this booklet tells how



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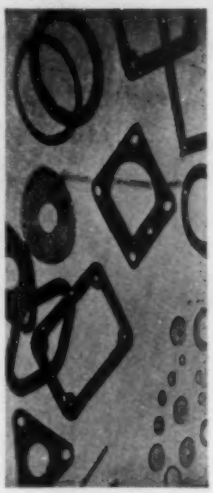

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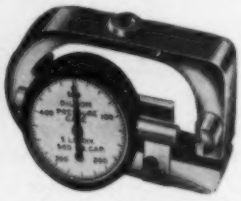
Mechanical PRESSURE GAUGE



This compact instrument will accurately measure pressure or compressive loads in very small spaces—will flex millions of cycles without losing its resiliency. Sustains 25% accidental overload. Measures pressure in vises, hydraulic presses, spot welders, etc. Jeweled dial indicator for extreme accuracy. Range capacity to 5000 lbs. Low cost.

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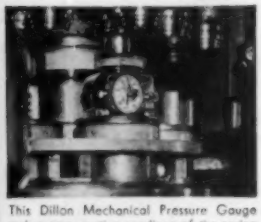

This Dillon Mechanical Pressure Gauge makes comparative readings of the spring pressure exerted against the bottom of tin cans by the base plate in a can seaming operation. Thus, the operator can tell if all base plates exert uniform pressure in each seaming station.

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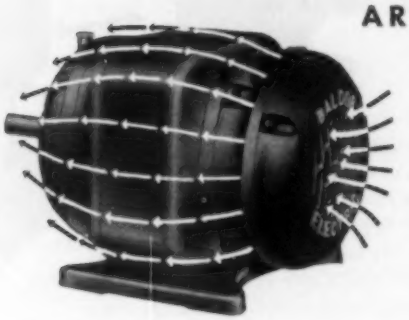
ARE SOLIDLY ENCLOSED—*but can't clog*



BALDOR STREAMCOOLED® MOTORS
of present NEMA dimensions still available. SINGLE PHASE, ¼ to 7½ h.p. THREE PHASE, ⅓ to 20 h.p.

BALDOR STREAMCOOLED ball-bearing motors are SOLIDLY ENCLOSED, cooled by an outer-mounted fan in the bell-end. They cannot inhale dirt, dust, lint or abrasives. These motors require no dismantling for cleaning. They require less servicing — and have longer active life.

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STREAMCOOLED MOTORS
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flat
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STAMPINGS
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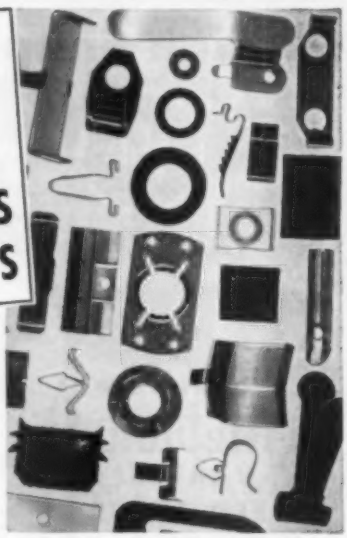

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how appliance manufacturers use

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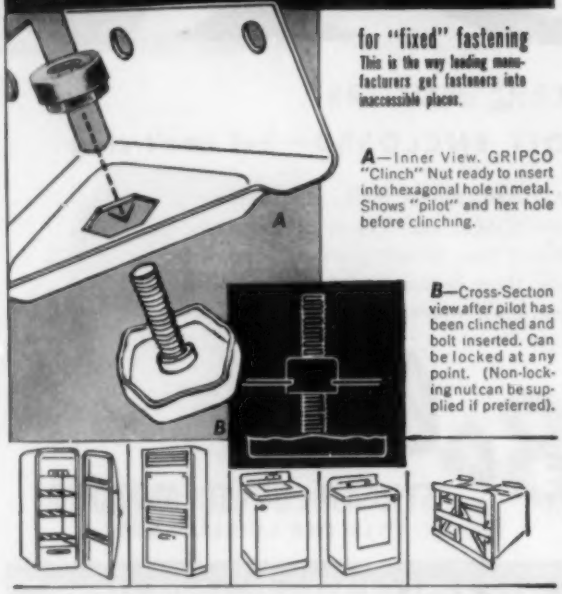

for "fixed" fastening
This is the way leading manufacturers get fasteners into inaccessible places.

A—Inner View. GRIPCO "Clinch" Nut ready to insert into hexagonal hole in metal. Shows "pilot" and hex hole before clinching.

B—Cross-Section view after pilot has been clinched and bolt inserted. Can be locked at any point. (Non-locking nut can be supplied if preferred).

● Makers of washers . . . dryers . . . refrigerators . . . ranges . . . freezers . . . room air conditioners and many other appliances are enthusiastic over these new and better fasteners—Gripco "Clinch" Nuts. In many cases they do a double job—*first*, to hold the product rigid and safe in its container during shipment, with no risk of bolts "backing out"—and *second*, for holding the adjustable "levelers" after the appliance is delivered to the user. If you have any application with hard-to-get-at fastening or that needs additional threading depth for applying bolts to thin metals, investigate Gripco "Clinch" Nuts.

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GRIPCO Pilot Projection Weld Nuts Circular pilot accurately positions nut in the bolt hole, for resistance welds. No jigs necessary. Two pilot heights for different gages of metal.

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4—Oil or water do not affect Gripco locking action.
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6—Cost less because of simple design.

Write for samples, mentioning types and sizes of nuts you use. 400

GRIPCO **GRIP NUT COMPANY**
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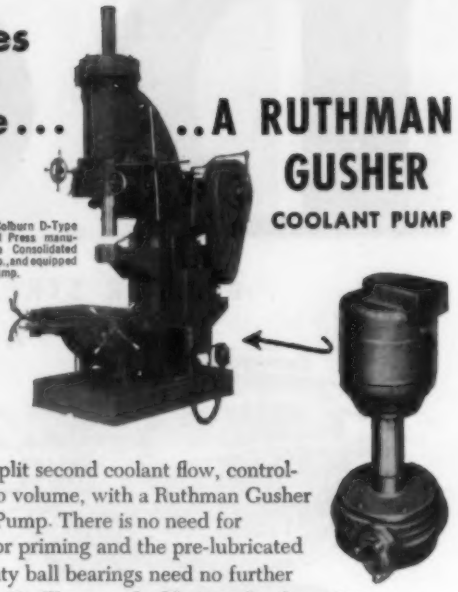
Saves You Time... ..A RUTHMAN GUSHER COOLANT PUMP



Illustrated is a Colburn D-Type Heavy Duty Drill Press manufactured by the Consolidated MachineTool Corp., and equipped with a Gusher Pump.

You get split second coolant flow, controllable as to volume, with a Ruthman Gusher Coolant Pump. There is no need for packing or priming and the pre-lubricated heavy-duty ball bearings need no further attention. You'll save valuable time for the entire life of your metal cutting machinery when you specify Gusher Coolant Pumps.

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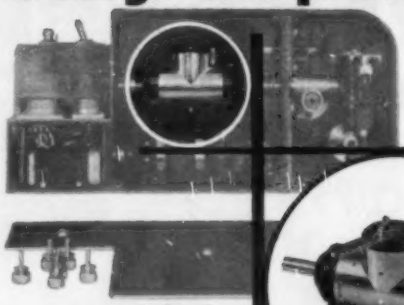

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- Permanently lubricated
- Your choice of 6 controls
- Speeds up to 10,000 RPM
- Nominal output .025 HP

Model 3 B lever type control

Design engineers at Century Geophysical Corporation make use of the Metron Variable Speed Changer to give them continuously adjustable chart speeds in their miniature oscillograph.

Century engineers find that it is simpler and more economical to use Metron Miniature units as components than to design and build their own.

Metron Variable Speed Changers are designed into countless products that call for changes in speed. The units are small—only 4 3/16" long—to fit minimum space. They are smooth and accurate in operation and cover infinitely variable output speeds from 5:1 step down thru 1:1 to 1:5 step up.

● For further information about how Metron units can simplify your costly speed changing problems, write for Bulletin 99.

Metron **INSTRUMENT COMPANY**
444 LINCOLN ST., DENVER 3, COLO.

NEW
High Density Compressed
FIBER · GLASS

To help you soften impact, or absorb vibration

L·O·F announces a new, high-density, fibrous glass material with a wide range of applications. Can be used in sheets or formed to make safety pads, housings and other shapes.

L·O·F High Density Compressed Fiber·Glass offers the following advantages:—

1. Absorbs and reacts to impact more slowly than other materials; affords extremely effective shock protection.
2. Absorbs vibration-borne sound.
3. Excellent thermal insulation in the lower density range.
4. The glass fibers will not burn, mildew, rot, absorb moisture or odors, or support fungi.

High Density Compressed Fiber·Glass is now being used in the following design applications:—

For impact absorption—in automobile safety pads and arm rests.

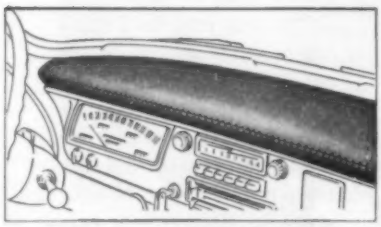
To absorb vibration—to form blower housings and intake deflectors in air conditioners; for automobile roof liner.

For thermal insulation—plus vibration absorption, as a low-cost breaker strip between metal panels.

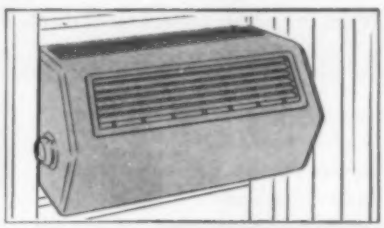
In making High Density Compressed Fiber·Glass, Super·Fine is cured under heat and pressure. Densities vary from 3 lbs. to 50 lbs. per cubic foot. Housings and other shapes can be molded at the Libbey·Owens·Ford plant in Parkersburg, W. Va.

High Density Compressed Fiber·Glass may be just the material you need to solve an impact-, vibration-noise or thermal-insulation problem. For further information, please contact your nearest L·O·F office (offices in 26 major cities). Or write: Libbey·Owens·Ford Glass Company, Fiber·Glass Division, 424 Wayne Building, Toledo 3, Ohio.

Hi, Mr. Designer! How can YOU put me to work?



In this safety pad, molded from High Density Compressed Fiber·Glass, the leading edge (where impact could be expected) is made softer than the rest of the pad.



This blower housing for an air conditioner, made of High Density Compressed Fiber·Glass, absorbs vibrational noises; helps to solve one of the chief problems in air-conditioning design.

High Density Compressed Fiber·Glass is specified as a low-cost breaker strip between panels in prefabricated steel homes, serving as weather seal, thermal insulation and vibration absorber.

*High Density Compressed Fiber·Glass

L·O·F GLASS Corning FIBER·GLASS

FIBER · GLASS

LIBBEY·OWENS·FORD GLASS COMPANY
FIBER·GLASS DIVISION

WHEN YOU WANT NYLON PERFORMANCE
with low tooling cost... design with

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APPLICATIONS
Bearings
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Coil forms
Gears
Rollers
Thrust washers
Valve seats
Wearing surfaces
Insulators

CHARACTERISTICS
Abrasion resistance
Electrical insulation
Light weight
Heat resistance
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Toughness
Resilience
Low coefficients of friction

You can fabricate parts readily (drill, tap, thread, turn, mill, blank) from standard shapes of POLYPENCO nylon on standard shop equipment. This keeps tooling cost low and makes nylon economical without costly tooling.

Call on us for engineering help. We will tell you if nylon is practical for the application, how to fabricate it—or we will fabricate it for you. Write for prices or technical data.

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* registered trademark of the Du Pont Company

But why MEN over 45?

Our doctors still don't know *why*, but if you are a man over 45 you are six times as likely to develop lung cancer as a man of your age twenty years ago. They *do* know, however, that their chances of saving your life could be about *ten times* greater if they could only detect cancer long before you yourself notice any symptom. (Only 1 in every 20 lung cancers is being cured today, largely because most cases progress too far before detected.)

That's why we urge that you make a habit of having your chest X-rayed every six months, no matter how well you may *feel*. The alarming increase of lung cancer in men over 45 more than justifies such precautions. Far too many men die *needlessly!*

Our new film "The Warning Shadow" will tell you what every man should know about lung cancer. To find where and when you can see this film, and to get life-saving facts about other forms of cancer, phone the American Cancer Society office nearest you or simply write to "Cancer"—in care of your local Post Office.

American Cancer Society

IS YOUR PROBLEM MORE ECONOMICAL OPERATION

IN YOUR SMALL ENGINES?

Specify

BENDIX

THE MOST TRUSTED NAME IN MAGNETOS

- ✓ Simplicity in design.
- ✓ Waterproof moulded coil.
- ✓ Lower operating cost.
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- ✓ Higher voltage at starting speeds.
- ✓ Constant spark over entire speed range.
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There is no need for inflation in small engine operating and maintenance costs if you specify Bendix magnetos. The fact is, a new high in dependable performance can be obtained at no extra cost. The basic design of these rugged lightweights enables Bendix to meet the operating problems of *every type* of small engine, as well as *every pricing requirement.* If you want to hold down operating costs for the small engines you employ, be sure to insist on Bendix—the most trusted name in magnetos. Write us for full details.

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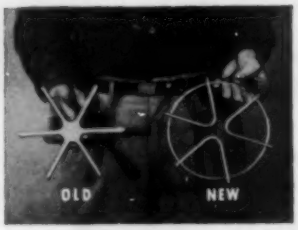
"Simplicate it, and add more lightness!"

. . . The goal of modern industry — as expressed by one of America's greatest research engineers.

That's the sole objective of the *Titchener Test:* To see whether a product—yours, for example—can be made simpler . . . lighter . . . cheaper.

"Simplicated" Case Histories

Selected from among some 200 manufacturers who have taken the *Titchener Test* . . .



Saves Manufacturer $4,015!

Design of new portable stove submitted to Titchener called for die-cast burner grate. Tool cost for die casting quoted at $3,000 — estimated unit cost, 30¢. Titchener designed simple wire grate. Tool cost, $235; unit cost, 25¢. Savings on first order for 25M — $4,015.

Wire Design Reduces Weight 75%

The sheet steel motor mount shown at left was replaced by the Titchener-designed welded wire-and-strip assembly at right. Result: Weight reduced 75%. Costs reduced. Availability of material improved. Appearance much improved.

Here's How The *TEST* Works

Say the design of your product includes a casting or forging, stamping, tubing or sheet steel part. You send prints or a sample of the part to Titchener. A group of wire-forming engineers studies it from all angles . . . function, design, cost. If they find that wire can do a better job they'll submit drawings or a sample of the revised piece for your consideration. They'll also quote Titchener's low price for mass-producing the part. If they honestly feel wire can't improve your product, they'll tell you that, too.

The Titchener Test costs you nothing . . . imposes no obligation. It's unbiased and confidential. Merely send print or a sample . . . describe your wants in a covering letter.

Send for *FREE* Handbook!

"Use of Wire Construction in Product Design"

An illustrated 20-page technical handbook sent free to management, production, purchasing and engineering men. Write for your copy.

WIRE GOODS Headquarters

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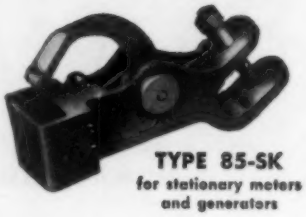
Manufacturers of Wire Parts for Over 65 Years

MAXIMUM motor and generator **PERFORMANCE** with

FLOWER

BRUSH HOLDERS

TANDEM
for slip ring service



TYPE 85-SK
for stationary motors and generators

There's a reason for the claim: "maximum motor and generator performance" — long life for both Brush Holders and Brushes is built into the units with highest quality bronze castings, precision machining — proper designing.

Known throughout industry for their enduring qualities, some of these units have lasted more than 24 years, under critical operating conditions. High resistance to vibration and wear assures you, your FLOWER BRUSH HOLDER will not cause breakdowns in production.

GET COMPLETE INFORMATION NOW!

WRITE FOR CATALOG 4 P

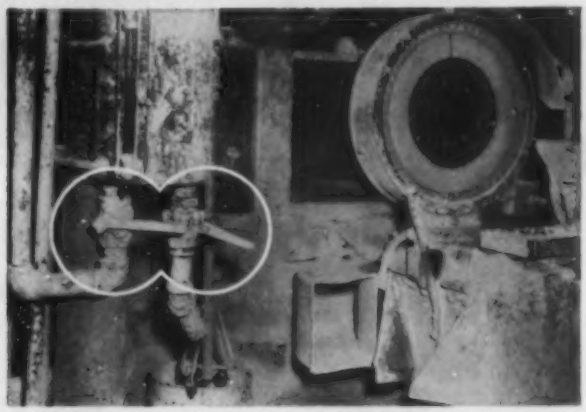
FLOWER PHILADELPHIA

D. B. FLOWER MFG. CO.

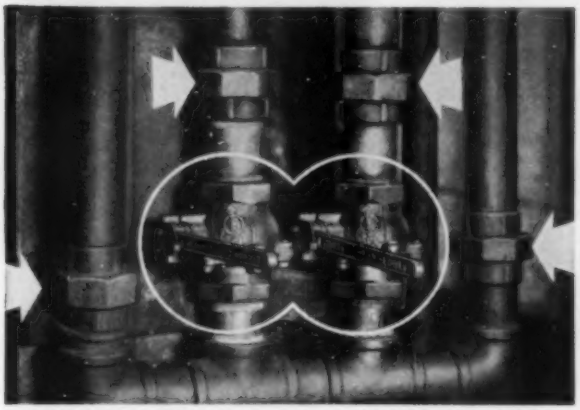
1217 Spring Garden Street, Phila. 23, Penna.

Do you need a MAINTENANCE-FREE VALVE?

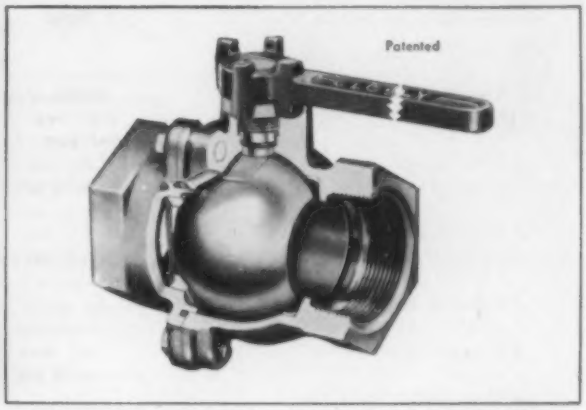
Maintenance-Free in Coolant Service. Previous valves on this grinding machine were repaired or replaced at least once weekly. The present Rockwood Ball Valves, operating 500 times daily, have required no maintenance for over a year.



Maintenance-Free in Glass Making. Replacing valves that lasted only 8 weeks, Rockwood Ball Valves are working 24 hours a day, opening and closing continually. They have not been serviced in over a year.



Maintenance-Free on Quenching Lines. Rockwood Ball Valves in an annealing room handle unfiltered water at 100 psi. Opening and closing 60 times a day, they have outlasted other valves 4 to 1 — without maintenance.



Maintenance-Free for Steady Savings. In Rockwood Ball Valves the chrome-plated ball stands up under constant abrasion, pitting and scratching. They pay for themselves over and over with extra-long, trouble-free service life.

Note these other exclusive features!

Full Round Flow — assuring fast, efficient operation, less friction loss.

Leakproof — in closed position, pressure of fluid automatically positions ball against synthetic rubber seat to form a tight seal.

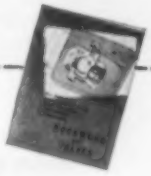
Quick Opening and Closing — needs only ¼ turn even under full pressure.

From alcohol to asphalt, from petroleum to pickling acids, Rockwood Ball Valves perform with trouble-free continuity. Longer time between replacements, less maintenance on the job. Comes in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. The coupon will bring you complete information.

ROCKWOOD

THE FLOW IS AS ROUND AS THE PIPE ITSELF

***FULL-FLOW* BALL VALVES**



ROCKWOOD
SPRINKLER COMPANY
106 Harlow Street, Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....

Title.....

Company.....

City.....

Zone..... State.....

Memo to Design Engineers

Only Stearns Magnetic Brakes Answer YES to These 20 Important Points

GENERAL

- ✓ Torque ratings range from 1 lb. ft. to 575 lb. ft. covering brake requirements on motors from 1/20 hp. to 100 hp.
- ✓ Visual indication of lining wear
- ✓ External adjustment for lining wear (when needed)
- ✓ Easy single-action torque adjustment
- ✓ External manual release
- ✓ Rugged construction
- ✓ Easy lining replacement
- ✓ Operate on motor mounted at any angle
- ✓ NEMA C mounting
- ✓ Floor mounting
- ✓ Stearns mounting (Standard for many motor manufacturers)

ENCLOSURES

- ✓ Standard through weatherproof
- ✓ Dust-tight, waterproof
- ✓ Underwriter's Laboratory-approved explosion-proof
- ✓ Marine service
- ✓ Navy service A (high impact)

ELECTRICAL

- ✓ Operate on any AC voltage, single, two or three phase
- ✓ DC shunt or series windings
- ✓ Maximum electrical safety factor
- ✓ Single coil in all sizes

8072

Stearns fast stop, instant release magnetic brakes are specified by the nation's leading motor manufacturers. For complete facts on Stearns Magnetic brakes and clutches, write for new detailed Bulletin 226-C-1.

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 631 S. 28th St., Milwaukee 46, Wis.

need information on **transmission equipment?**

reach for your Product Design File

"... a great time-saver"

These manufacturers' catalogs are instantly available in Section 3a. of your Product Design File:

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Allis-Chalmers Mfg. Co.
American Flexible Coupling Co.
Apex Machine & Tool Co.
Boston Gear Works, Inc.
Cullman Wheel Co.
Dodge Mfg. Corp.
Falk Corporation
Foote Bros. Gear & Mach. Corp.
Industrial Gear Mfg. Co.
Instrument Gear Works
James, D. O.,Gear Mfg. Co.
Link-Belt Company
Lovejoy Flexible Coupling Co.
Morse Chain Company
Raybestos-Manhattan,Inc.
Rockford Clutch Div
Stearns Magnetic Inc.
Twin Disc Clutch Co.
Warner Elec. Brake & Clutch Co
Winsmith, Inc.

In other sections of the File you will find additional catalogs containing useful information on product forms, characteristics, performance and use.

Sweet's Catalog Service

Division of
F. W. Dodge Corporation
119 West 40th Street,
New York 18, N. Y.

MICROLITE Glass Fiber Insulating Wool is soft all right. It's so soft you'd be surprised how tough it is. But try pulling it apart. You'll see in a minute what the extra-long fibers have to do with that extra tensile.

The longer fibers are made possible by Glass Fibers' own Electronic-Extrusion. *No other producer of glass fibers uses this process.*

MICROLITE *insulates effectively against heat transfer*

MICROLITE *is clean and sanitary—fungus-and-bacteria-proof*

MICROLITE *is inorganic, resists fire and moisture*

MICROLITE *is an excellent absorber of unwanted noise*

MICROLITE *resists settling under vibration*

MICROLITE *compresses readily, springs back fully*

MICROLITE *is easily fabricated—cuts with scissors*

Because Microlite is so soft and light and pleasant to the touch (doesn't itch either!), and at the same time has such remarkable tensile strength, it can be handled and applied with maximum speed, ease and sureness. This is important whether you are designing insulation for a railroad car or a home freezer. Or any of a score of other products *you* could name.

For an illustrated, descriptive 4-page folder and sample write to Glass Fibers Inc., 1810 Madison Avenue, Toledo 2, Ohio.

VITRON Yarns • Rovings • Micro-Fibers • **DURAMAT** Vapor Barriers
BLUE FLAG Pipe Wrap • **MICROLITE** Thermal and Acoustical Insulation • **VIBRAGLASS** Mounting and Packaging Materials
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GLASS FIBERS *INC.*

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Proof of **WAKEFIELD** *Performance*

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For years, the Wakefield Bearing Corporation has produced all types of oilless and self lubricating bearings, bushings and machine parts. In addition, Wakefield holds an enviable reputation for quality and reliability in the production of all types of Special Textile Bearings and Parts including wood bearings, white wood turnings, swifts and swift parts and textile loom sheaves.

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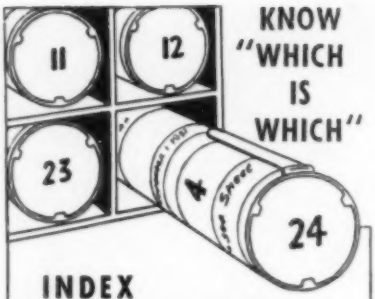

KNOW "WHICH IS WHICH"

INDEX ROLLED DRAWINGS

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Write for Catalog, or send $1.50 for 1 dozen Clips (and Labels), ⅜" head diameter.

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OSBORN

You get *Quality*

Osborn teams up with engineers to apply brushing power to many deburring, finishing and cleaning operations. This design and production know-how, plus the right brushes for the job assures profitable results.

when you specify
DEBURR AND BLEND

THE lower picture shows the results obtained with an Osborn Brushamatic Machine. This power brushing method does what hand deburring cannot accomplish . . . it removes burrs and feather edges thoroughly and it *blends* surface junctures. The resultant smooth radius of edges decreases stress concentrations, improves service life. Its quality is *uniform* piece after piece.

When you specify this modern method, you also get *faster production!* The gear shown required 3 minutes for hand deburring and only 18 seconds by the Brushamatic method.

Your **O**sborn **B**rushing **A**nalyst will gladly help you find out how this or other push button brushing operations can be applied to your problems. Call your **OBA** today or write *The Osborn Manufacturing Co., Dept. HH-1, 5401 Hamilton Ave., Cleveland 14, Ohio.*

This booklet suggests many ways by which Osborn Power Brushes improve products and lower costs. Write for your free copy of "Automatic Deburring."

Osborn Brushes

OSBORN BRUSHING METHODS • POWER, MAINTENANCE AND PAINT BRUSHES • BRUSHING MACHINES • FOUNDRY MOLDING MACHINES

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ESTABLISHED 1919

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This assures complete satisfaction for K. & J. customers at all times.

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DESIGN ENGINEERS

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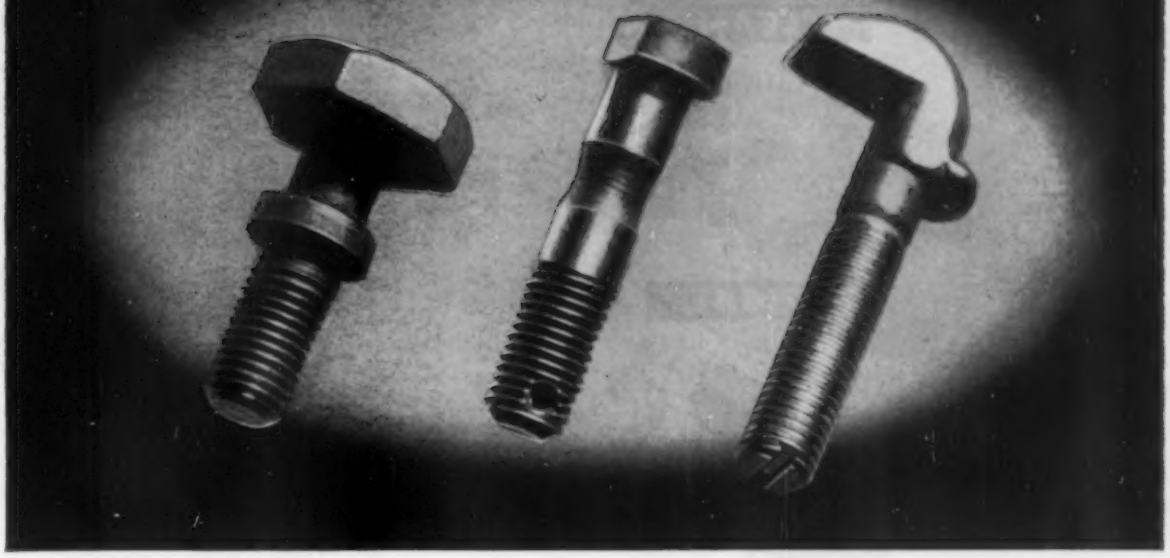
Product Engineering

To tap this manpower market, just send in your advertisement before Feb. 16 directly to us at 330 W. 42nd St., N. Y. 36, N. Y.

BRING YOUR "SPECIAL" PROBLEMS TO *National*



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When you have any "special" fastening problem . . . requiring an unusual type of bolt, nut, screw, pin or headed or threaded part . . . our engineers can help you design it . . . and we can produce it economically on our wider range of cold heading equipment and specialized machinery.

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Representatives in Chicago, Cincinnati, Detroit, New York, Philadelphia, Kansas City, Milwaukee, Rochester, Denver, St. Louis, San Francisco, or Seattle —write or call direct to:

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January 31-
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Clean, bright, accurate, strong — that's the story of Ritco Drop Forgings. We produce parts to your blueprint in steel or non-ferrous metals, in weights from ¼ lb. to 15 lbs.

Come to Ritco for Drop Forgings, special fasteners, and finished bolts with regular or heavy heads. Also, take advantage of our complete facilities for finishing — machining and grinding. Send blueprints and specifications for free estimates. Rhode Island Tool Company, 148 West River Street, Providence 1, Rhode Island.

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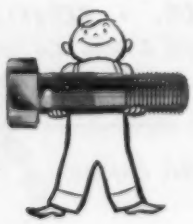
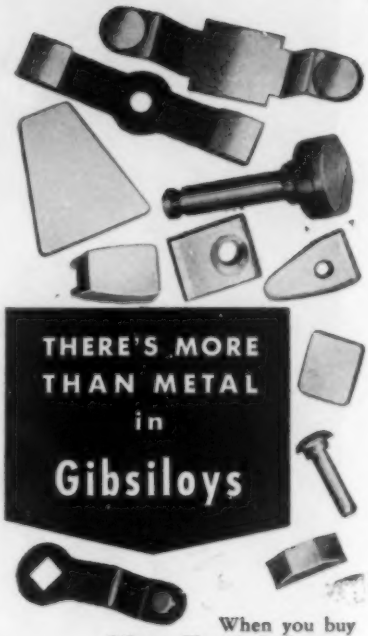


Exclusive New England Representatives for Cleveland Cap Screw Co.



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When you buy Gibson Electrical Contacts for your electrical and electronic applications, you get:

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Gibson produces electrical contacts in a complete line of materials, forms and assemblies—enabling Gibson to supply economical and practical contacts to meet virtually any need. Because of the completeness of our line, Gibson engineering service is unbiased. It is available to you at no obligation.

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Gibson introduced to the industry Ductile Gibsiloys—contacts made from metal powders—to answer customer demand for combinations of physical and electrical properties not possible with alloyed contact materials. The versatility of Gibsiloys is ready to meet *your* needs.

Let us cooperate to solve *your* problems. To learn more about Ductile and other Gibsiloy contacts, write for Gibson Catalog C-520. It contains much helpful engineering information.

CONTACT GIBSON FIRST

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Manufactured by

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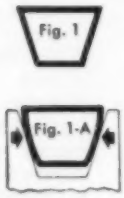
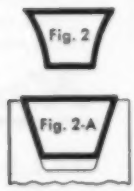
Prove this yourself!



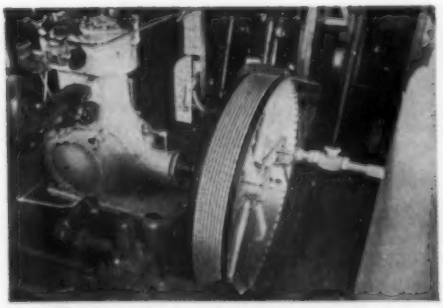
Take any *straight-sided* V-Belt (Fig. 1). Bend it—as it bends in going around a pulley. The sides will at once *bulge out* (Fig. 1-A). Clearly, those bulging sides will press *unevenly* against the V-pulley—and this causes *extra wear* at the points shown by the arrows (Fig. 1-A).

Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)



Instead of *bulging*, the precisely engineered CONCAVE SIDES merely *fill out* to *fit exactly* in the sheave groove (Fig. 2-A). The sides press *evenly* against the V-pulley. All wear is distributed *uniformly* across the *full width* of the Gates Vulco Rope—and this means *longer* belt life and *lower belt costs* for you!

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE Sides—the Gates Vulco Rope!



Typical Gates Vulco Rope Drive—the Gates V-Belts are built with Concave Sides to insure longer belt wear.

Gates VULCO ROPE DRIVES

REG. U. S. PAT. OFF.

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and in 71 foreign countries.

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CR-540

IMAGINE TRYING TO GET IN HERE TO HOLD NUTS!

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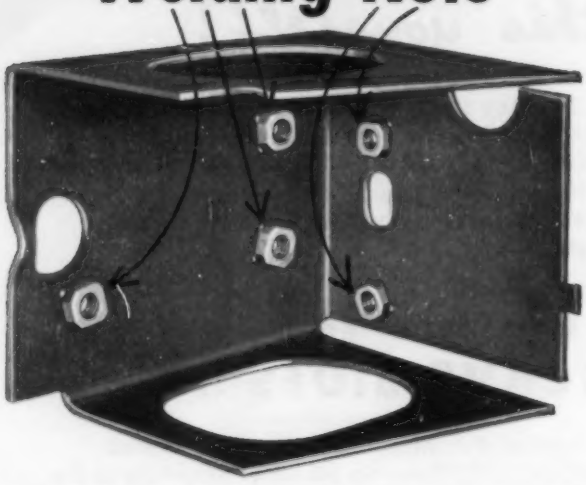

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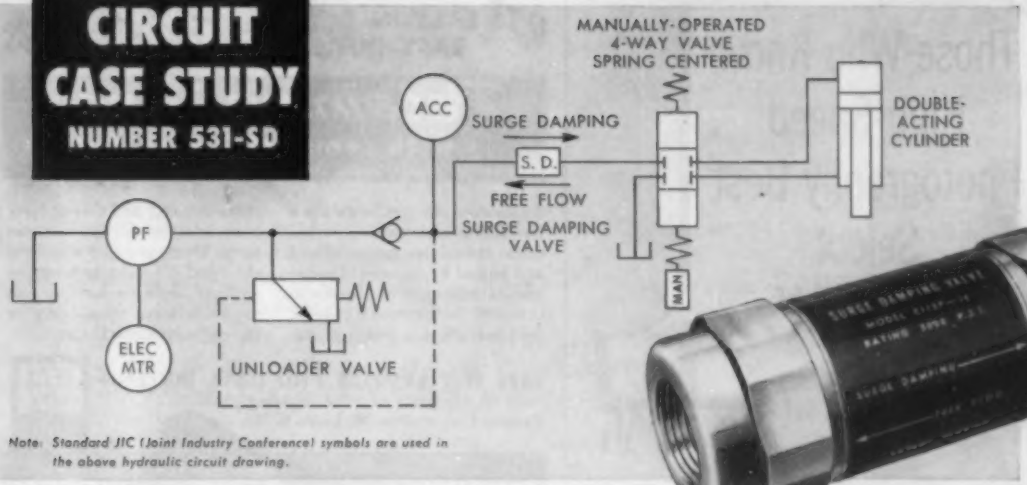
CIRCUIT CASE STUDY NUMBER 531-SD



Note: Standard JIC (Joint Industry Conference) symbols are used in the above hydraulic circuit drawing.

½ ACTUAL SIZE

DENISON Surge-Damping Valve

prevents destructive, noisy *shock* in hydraulic systems

Fast operating at pressures up to 5000 psi without loss of cycle time

The circuit above shows a typical way to provide for intermittent ram action.

A relatively small pump is used, as reserve pressure is stored in the accumulator between applications of ram effort. When pressure in the accumulator reaches a preset maximum, the unloader valve diverts pump volume to the reservoir at negligible pressure.

Shifting the control of the four-way valve causes the ram to descend on the work, instantly utilizing reserve pressure from the accumulator. Ordinarily, this sudden extra volume and pressure produces hydraulic shock, which causes excessive noise and is apt to damage piping joints and seals.

The Denison **Surge Damping Valve** prevents, rather than absorbs, this hydraulic shock. It is a normally closed valve, but when line pressure is directed toward the inlet side, it allows a gradually increased flow of oil until fully opened. Then virtually free flow is maintained until oil flow is interrupted—no matter how briefly. The valve then resets instantly, ready for the next ram action.

Operation is simple and positive. The valve body houses a close-fitting spool which must move against and displace a cushion of oil to permit flow through the valve. As the surge of pressure strikes the spool, oil in the cushion escapes through a small orifice. Oil rushing out of this orifice is directed against a normally open flow control device. This flow control is hydraulically unbalanced; therefore, it tends to close under this pressure—the higher the surge pressure, the greater the throttling effect. In other words, speed of valve opening is inversely related to surge pressure increase.

Even under heaviest shock pressures, the valve takes only a split-second to act. In fact, tests prove it takes no longer to act than the duration of an uncontrolled shock impulse.

Denison **Surge Damping Valves** are made in both industrial and aircraft types, for pressures to 5000 psi. They require no adjustments of any kind, need no maintenance, have no moving seals, adjust automatically to any working pressure in any type of circuit, and do not interfere with other circuit functions. An integral check device provides free reverse flow.

The highly compact and efficient ***Surge Damping Valve*** *(the largest is shown above, one-half actual size) is typical of the complete line of Denison's oil-hydraulic components for circuit pressures to 5000 psi. Wherever the advantages of oil hydraulic equipment can be applied, you can be sure of best results, longest service, and less maintenance when you insist on Denison HydrOILic Equipment. Let us give you full information on hydraulic equipment for any need. Request Bulletin 146; there's no obligation.*

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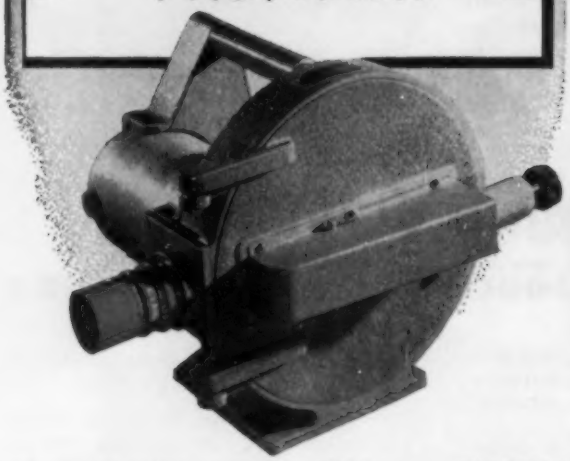

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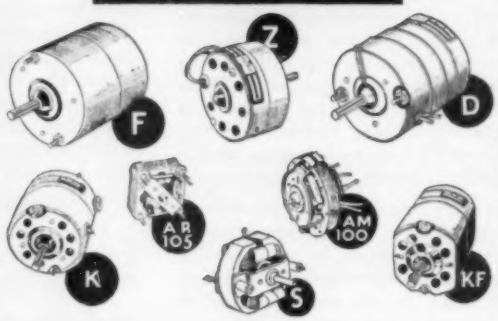

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All described in the Heinze catalog.

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CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

HOW the most remarkable glass in 4000 years was invented... Modern kitchen ranges are full of ideas... Do you know how glass conducts electricity?

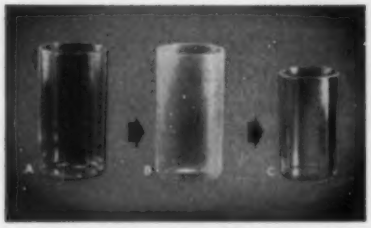
People are always looking for something new and better. You spend most of your time seeing that they get it.

We do the same, and want to tell you—quickly—of developments in glass that may suggest applications useful to *you.*

Hence this Bulletin, the first of a series which will talk briefly about new and unusual glasses—in the hope that you will let us send you more complete information. For your convenience, there's a coupon below.

most remarkable glass

In 1952 Philadelphia's Franklin Institute presented the John Price Wetherill Medal to Corning's Dr. Martin E. Nordberg and Harrison P. Hood for inventing the most fabulous of glasses—VYCOR brand 96 per cent silica glasses.



Evolution of a VYCOR jar: A—formed by conventional glass blowing; B—"thirsty glass"; C—finished product.

These two scientists discovered a composition that appeared to be a combination of two distinct types of glasses. One type could be dissolved out, leaving a skeleton of 96 per cent or more of silica filled with so many millions of holes that a one-inch cube contained some 60,000 square feet of hole surface.

This new child of research was dubbed "thirsty glass" because, just sitting around, it absorbed moisture right out of the air. But our researchers were on the trail of something even more exciting. They heated their "thirsty glass" and it shrank to two-thirds its original size. The millions of little holes vanished and left a vacuum-tight glass that looked like any other—except that you could take this new glass white-hot from a blazing furnace and plunge it into ice water without the slightest injury. It was a glass as ideal as fused quartz, but different since it could be melted, mass produced, and worked in its original state like ordinary glass.

The newest use for VYCOR brand 96 per cent silica glasses is in Sylvania's instant-heat lamp for electric ranges. *We'll tell you more in later bulletins about other uses these glasses have already found. If you'd like to know more NOW, just check the coupon below.*

ideas

Today's smart gas and electric ranges have wrought a kitchen revolution. And glass has made its contribution—design-wise and utility-wise.

Some of the newest ranges include several kinds of glass items. PYREX brand oven door panels that let you see what's cooking; broiler plates, door handles, broiler shields, oven roundels to protect non-heat-resistant lamps. *Opal* glasses for decorative stove-top lighting. *Multiform* glass beads for electric surface units. Top-of-stove burner protection units made of VYCOR brand 96 per cent silica glass. Attractive designs and name plates permanently captured in *photosensitive glass* panels. (Photolay, we call this application. It gives a 3-D effect to anything that can be reproduced photographically.)

Sears-Roebuck's new Kenmore range with a Sylvania instant-heat lamp unit which has a VYCOR bulb and tinted cover plate.

Wonder if there might be an idea or two for you in what the modern stove designer is doing with glass? We'd be glad to tell you more.

conducting electricity

One of the interesting exhibits at the Corning Glass Center shows an electric light bulb mounted in the middle of what looks like an ordinary plate glass window pane. But push a little doorbell button beneath the pane and behold—the electric bulb lights up. The window pane isn't a window pane at all. It's a glass that conducts electricity—E-C (*E*lectrically *C*onducting) glass.

A transparent film on one side of a PYREX panel acts as a resistance heater with power ratings as high as 10 watts per surface square inch. Switch 115- or 230-volt alternating current through it and you get up to 650° F.—enough to char but not ignite a piece of paper.

E-C glass is being used successfully today in portable and wall-mounted space heaters and in industrial heating and drying equipment, especially where *even heat distribution* is needed.

Our engineers have collected a good deal of information about E-C glass. We'd be glad to share it with you. For preliminary action, just put your mark on the coupon after E-C glass.

Flick a switch and this electric bulb mounted on a glass panel lights up. Magic? No—this glass conducts electricity.

If the items listed below don't seem to bear on your problem, we may have what you need at our fingertips. We'd like to hear from you.

▼

CORNING GLASS WORKS, 10-2 CRYSTAL STREET, CORNING, N. Y.
Please send me more information about VYCOR brand 96 per cent silica glasses ☐; kitchen range applications ☐; E-C glass ☐.

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Corning means research in Glass

BLC

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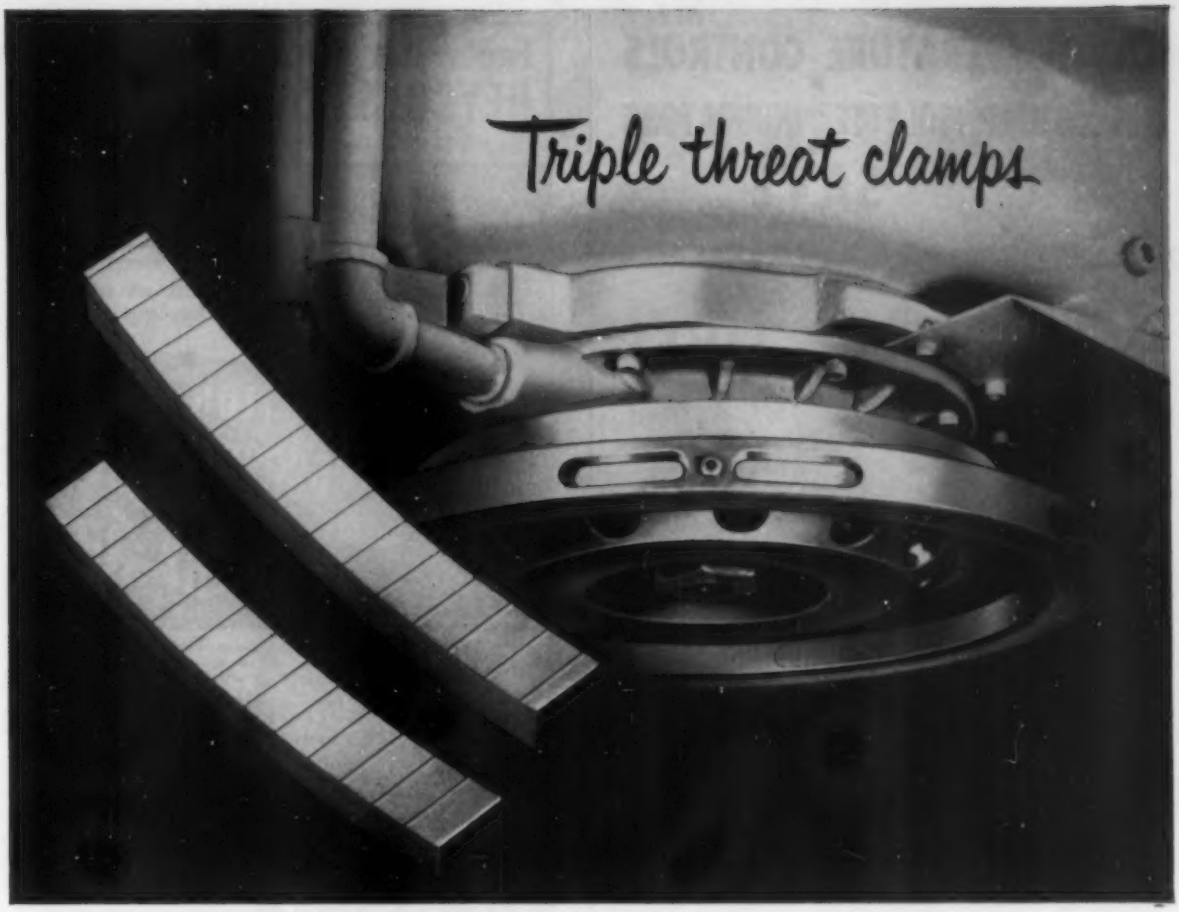

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First, the problem of holding the grinding wheel in place no matter how severe the vibration or how long the machine is used. The clamps are smaller in radius than the wheel. When the adjusting set screws are tightened so that the center of the clamp touches the wheel, the clamps hold the wheel by exerting a uniform spring pressure. They can continue to withstand this high pressure without relaxation, even over a prolonged period of time, because Berylco is an unexcelled spring material.

Second, material previously used in this application continuously attracted steel particles by magnetization. Thus the clamps were always sticking. Berylco is nonmagnetic and self-cleaning.

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This application shows why more and more designers consider Berylco an ideal engineering material. No other alloy combines such desirable properties as corrosion resistance, strength, conductivity, fatigue resistance, and ease of forming. To find out what Berylco can do for you, for engineering help or for sample material, write any of the sales offices listed below.

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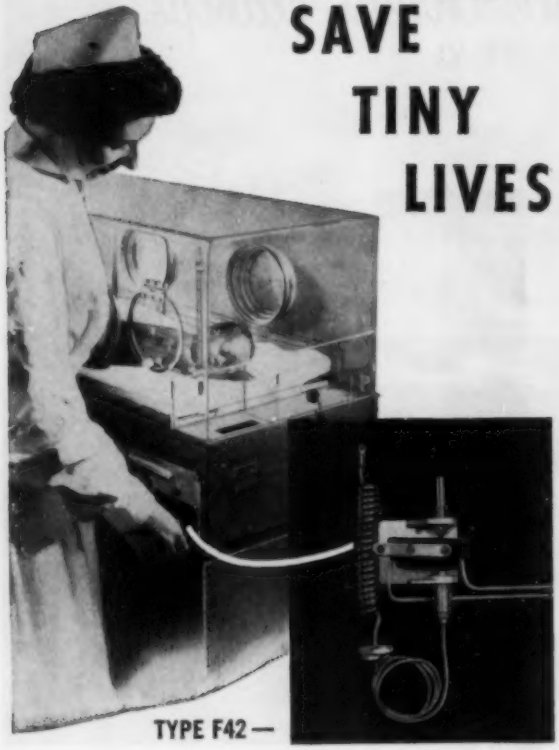

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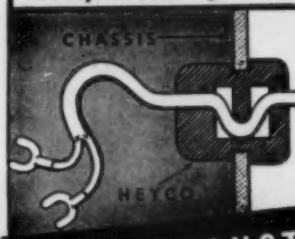
the Nylon Bushings that Anchor cord to housing



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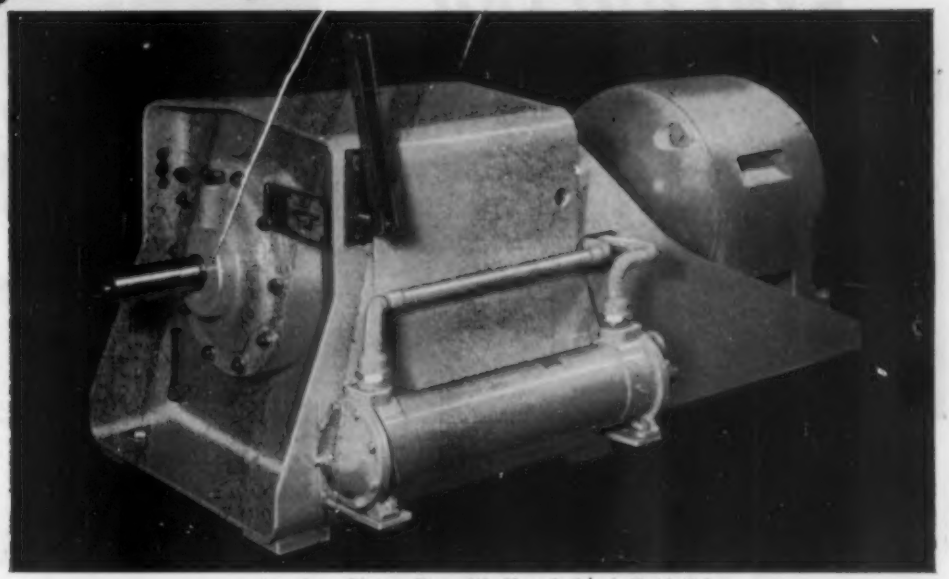
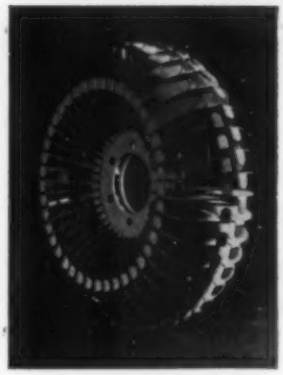
Gýrol FLUID DRIVE

TYPE VS CLASS 2



American Blower Type VS Class 2 Gýrol Fluid Drive



A phantom view of the driving and driven members, which provide smooth, reversible power transmission.

- **Can be reversed while in motion at any variable operating speed by merely reversing direction of rotation of motor**
- **Permits adjustable speed control over a wide range**
- **Built in several standard arrangements**

HERE IT IS! A brand-new fluid drive that will help you solve many tough industrial-drive problems. It's the American Blower Type VS Class 2 Gýrol Fluid Drive. A compact, self-contained, adjustable speed unit.

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It permits driving motors to reach full-load speed before engaging the load. In many cases simple across-the-line starting may be used. Adjustable speed may be obtained by either automatic or manual adjustment of the speed-control lever.

The new Type VS Class 2 Gýrol Fluid Drive is available in six sizes . . . 7½ through 800 h.p., at normal motor speeds up to 1800 r.p.m. Built in five standard arrangements, it can be used on a wide variety of industrial applications.

For complete information about the Gýrol Fluid Drive line, give your nearest American Blower Branch Office a call, or write us direct for free literature.

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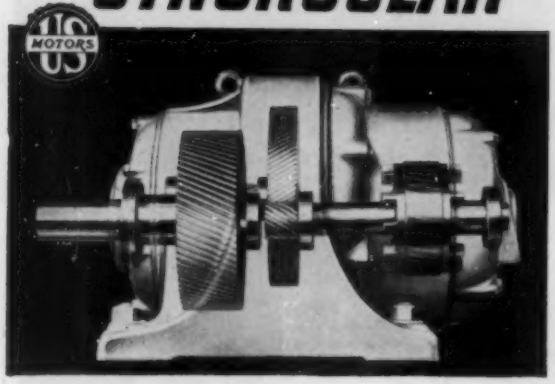

The motor that internally gears its speed

DON'T go to the expense of installing a gear box with extra coupling and guards to rig up slow speed for a motor. Install the *U.S. Syncrogear motor* and avoid extra contraptions. You'll simplify your power hook-up, save space, eliminate hazards and give your driven machine the most efficient power. The U.S. Syncrogear motor was one of the first complete integral power units, introduced 22 years ago. It's backed by experience, tested and proved performance and engineering "know-how" that only U.S. MOTORS can offer to those seeking the most dependable geared motor power.

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- Solid shank pinion
- Normalized castings
- Extra large oil reservoir
- Asbestos-protected windings
- In-a-line shaft
- Neat, streamline appearance
- Drip-proof surface

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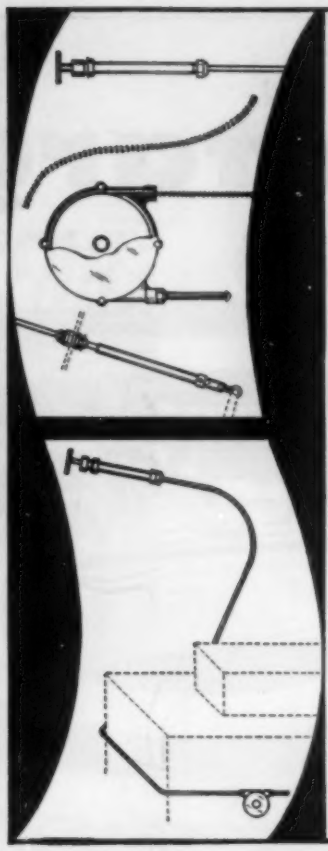

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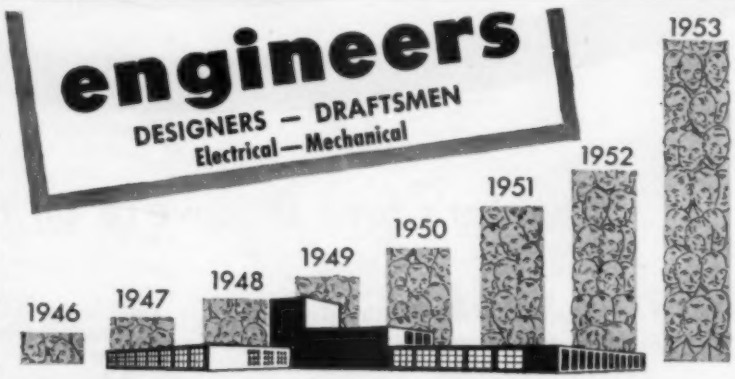

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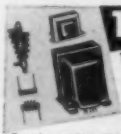

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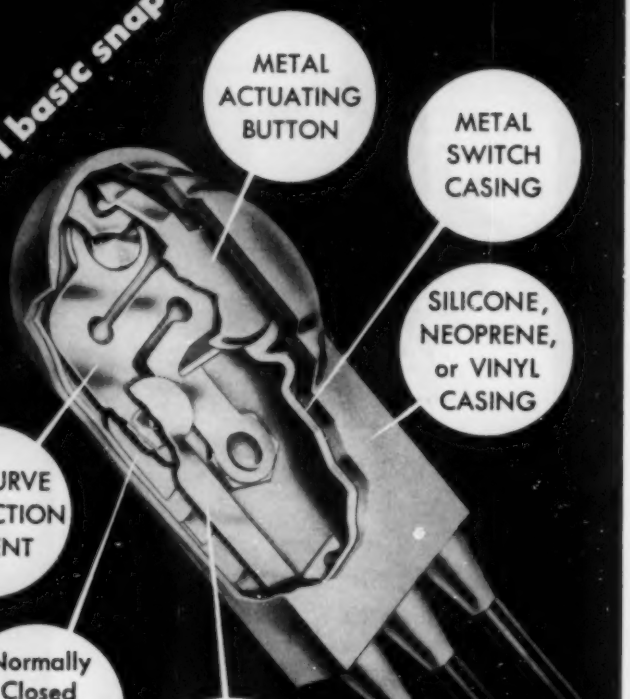

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Manufacturers of Thermal Devices and Waterproof Switches

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All Teflon† Yarn

LATTICE BRAID* PACKING

For Service Against the Most Destructive and Corrosive Acids on Pump Shafts and Valve Stems

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OFFICES IN LEADING INDUSTRIAL AREAS

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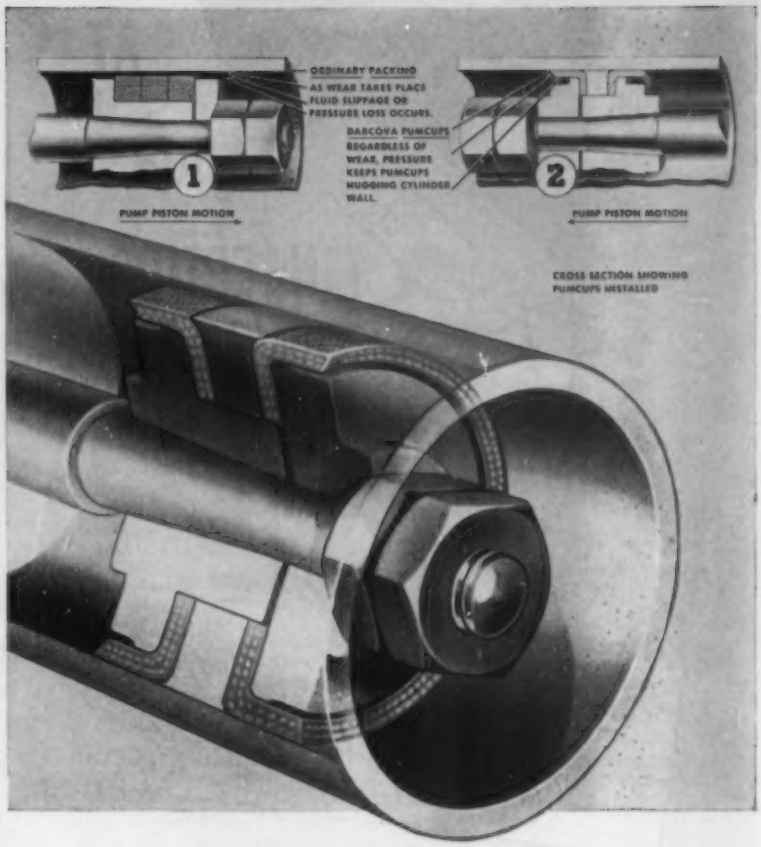
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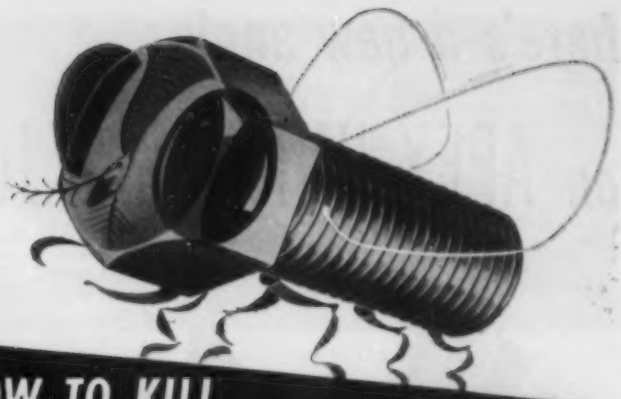

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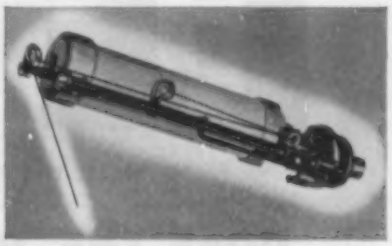

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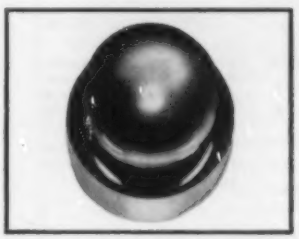

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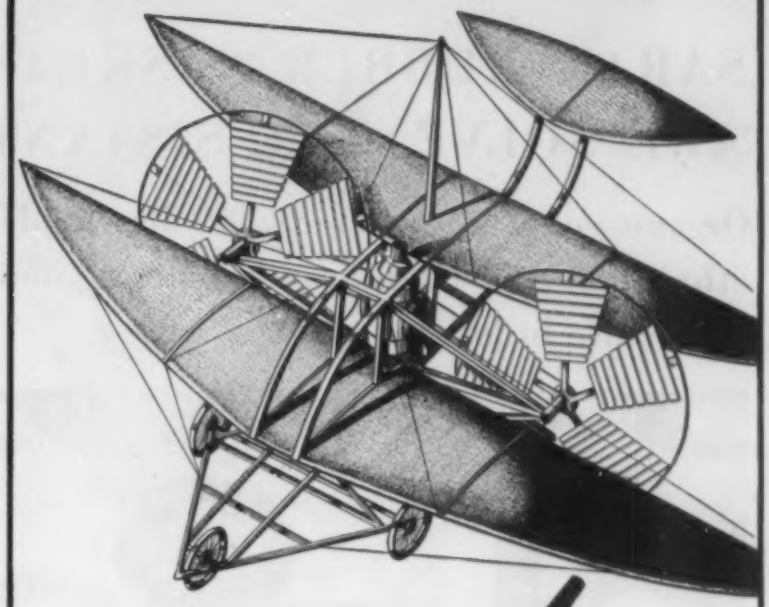

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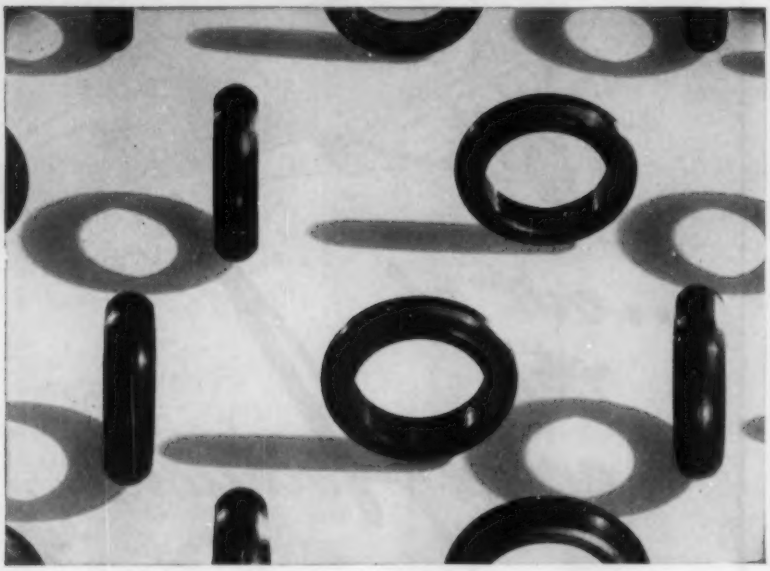

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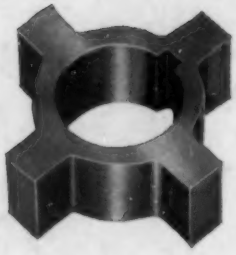

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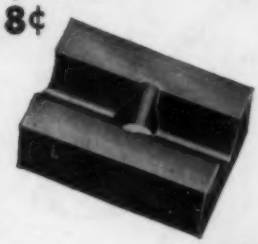

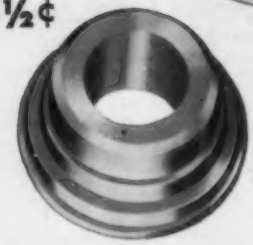

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